Snohomish River Basin Salmonid Habitat Conditions Review

Snohomish Basin Salmonid Recovery Technical Committee

September 2002

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Editor

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Introduction

This *Snohomish River Basin Salmonid Habitat Conditions Review* is part of the salmon conservation planning efforts in the Snohomish River basin.[1] Six habitat conditions are used to evaluate the functioning of 62 subwatersheds. Chinook and coho salmon and bull trout serve as proxy species for the salmonid species in the basin (which also includes chum, and pink salmon; steelhead, rainbow, and cutthroat trout, and mountain whitefish). This report builds upon and supercedes the *Snohomish River Basin Chinook Salmon Habitat Evaluation Matrix* (June 2000).[2] It is important to understand the scope and limitations of this report—what it does and does not address.

What this report does address

- The report characterizes habitat conditions in each subwatershed within the Snohomish River basin using criteria drawn from scientific literature.

- For each subwatershed within the Snohomish River basin, this report identifies intact aquatic habitats and specific problems that appear to be limiting the natural production of salmonids.

- Where sufficient information is lacking to make an informed determination at this time, the report identifies data gaps.

- Based on available information at the subwatershed scale, this report reflects the collective assessments and knowledge of Snohomish Basin Salmonid Recovery Technical Committee (Technical Committee) members with experience working in the basin.

What this report does not address

- This report is not a complete and thorough analysis of all causes and effects regarding the suitability of aquatic habitats for the natural production of salmonids throughout the Snohomish River basin. It is not a formal Limiting Factors Analysis.

- The results are not a formal means to link habitat conditions with future predictions of salmonid productivity.

- The results are not the sole and final technical basis by which to determine what actions should and should not be taken to protect or restore salmonid habitats.

- The framework uses performance criteria to evaluate salmonid habitat conditions. While this method is similar to the approach that an agency would use when undertaking a Section 7 consultation under the federal Endangered Species Act, this report is not a Section 7 Biological Assessment.

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[1] As used herein, the phrase "Snohomish River basin" is the same geographic area as Water Resource Inventory Area 7 (WRIA 7).
[2] This earlier report builds on the *Snohomish River Basin Conditions and Issues Report* (Pentec and NW GIS, 1999) that includes a range of issues broader than salmonid habitat.

Methods Overview

The six habitat conditions evaluated in this report are a grouping of the thirty-four habitat problems identified in the *Initial Chinook Technical Work Plan*[3] and other sources. To create this *Habitat Conditions Review*, the Technical Committee:

- Formed a Habitat Subcommittee to develop this assessment of subwatershed habitat conditions.

- Selected six habitat conditions to evaluate and developed a narrative for each so that a common set of assumptions were used to assess each subwatershed. The habitat conditions are:
  - Instream Artificial Barriers to Habitat
  - Sediment
  - Hydrology
  - Water Quality
  - Wetlands/Riparian Zone and Shoreline Vegetation/Large Woody Debris (LWD)
  - Shoreline Condition and Floodplain Connectivity

  Many of the conditions interact, which may amplify or dampen the overall effect on fish and their habitats. For example, reduced summer low flow can prevent fish swimming through culverts. Low flows, coupled with stream gravel accumulations, can lead to surface flows drying up. In another example, reduced levels of large woody debris (LWD) increase the likelihood of bed scour and fill events.

- Developed performance criteria for each habitat condition based on current scientific literature about salmon habitat requirements. Some of the criteria are the same as or similar to those used by the National Marine Fisheries Service. Others have been added to address the local environment.

- Established four categories to describe how habitat is functioning relative to each performance criterion: “intact”, “moderately degraded”, “degraded”, and “data gap”.[4] These are defined as follows:
  - **Intact.** Watershed processes and habitat structure reflect a natural state and provide optimum conditions to support salmonid populations.
  - **Moderately degraded.** Watershed processes and habitat structure have diverged from natural conditions and/or create some impairment to the natural productivity of salmonids.

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[3] The *Chinook Matrix* describes seven habitat conditions. For the *Habitat Conditions Review*, two of the habitat conditions (baseflow and peak flows) were combined into one (hydrology) because of similarity and interrelationship.

[4] In the *Chinook Matrix*, the assessments were described as Properly Functioning, At Risk, and Not Properly Functioning. For this report, the terminology was changed to avoid confusion with federal Endangered Species Act regulatory language.

- **Degraded**. Watershed processes and habitat structure have substantially diverged from natural conditions and/or provide severe impairment to the natural productivity of salmonids.
- **Data Gap.** No quantitative data are available for comparison with any of the performance criteria used in this analysis. Information related to the habitat condition may be cited.

If a habitat condition varies among performance criteria, among waterbodies, or within a waterbody in a subwatershed, the “worst case” assessment is used to determine the evaluation of the overall habitat condition for the entire subwatershed.

- Evaluated habitat issues at the subwatershed level consistent with the approach used by the Washington Department of Ecology (WDOE) (Gersib et al., 1999). The analysis focuses on the mainstem of each subwatershed, although detailed information on tributaries is included where available.

- Assessed each of the six habitat conditions in each of the sixty-two subwatersheds using existing literature (such as U.S. Forest Service watershed analyses, watershed management plans, the *Snohomish River Basin Characterization*, the *Snohomish River Basin Conditions and Issues Report*, and 303(d) list). Professionals with intimate knowledge of the characteristics of the subwatersheds were also consulted.

  Where possible, published scientific literature is used for each assessment. This includes books and journal articles that have been peer reviewed and accepted by scientists outside the author's workplace. Where published scientific literature does not exist, "gray" literature is used. This includes technical reports published by public agencies or a consulting firm working for a public agency that may have undergone peer review, but not a rigorous outside review process and acceptance for publication.

- Reviewed each assessment to ensure that the performance criteria were applied consistently across subwatersheds.

- Developed checklists for each subwatershed to document criteria used for each assessment.

Important Caveats

- The performance criteria and assessments in the *Habitat Conditions Review* are based on the scientific data that are currently available. As information improves and assessments are refined, some of the initial conclusions about the condition of habitats in these subwatersheds may change.

- The performance criteria are not intended for application at a reach scale. In fact, most of the criteria cannot be practically applied at less than a subwatershed scale.[5] This report does not provide site-specific information. Subwatersheds with large tributaries, dams, or other unique physical features will need to be subdivided by reach for proper assessment of site-specific conditions. As new information becomes available, other subwatersheds may also be assessed by reach.

- Many of the performance criteria are general and applied across landscape types (forest and wilderness, floodplains, and urban areas). Criteria are specific where possible (e.g., ecological standards have been determined and data are available).

- The assessments focus primarily on habitat conditions in the mainstem or river channel and may not represent the diversity of habitat conditions and concerns in each subwatershed.

- The assessments pertain only to specific conditions in each subwatershed. Although cumulative impacts of activities in upstream watersheds are not included, many performance criteria indirectly reflect cumulative effects (i.e., the presence of large woody debris and sediment can illustrate upstream conditions).

- The assessments reflect the limitations of the methods.

- The quantity and quality of data available vary among subwatersheds. As a result, the scale of application, performance criteria used, and levels of confidence in data interpretation differ. Comparisons between subwatersheds should be made with caution.

- Some assessments in this report may conflict with other independent assessments (such as U.S. Forest Service watershed analyses). This can be attributed to different performance criteria, data, and reviewers.

- Data are not available to address all performance criteria in all subwatersheds. In subwatersheds where data is available for only one performance criterion of a habitat condition, the assessment is based on that information.

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[5] The exception is that water quality criterion 4.1 (i.e., the 303(d) list) is applied at the reach scale.

Recommendations for Future Updates

As new scientific information becomes available, it could be used to refine and update this report. Future revisions could include:

- Adjustments to the performance criteria. Specific considerations are:
  - Further identification of percentage "breaks" to help distinguish between the categories of "intact", "moderately degraded", and "degraded".
  - For Habitat Condition 1 (Instream Artificial Barriers to Habitat): quantifying habitat loss; and distinguishing between resident and anadromous passage barriers.
  - For Habitat Condition 2 (Sediment): adding criterion for pool volume; for gravel bar formation and the distance between gravel bars; and adjusting the criteria to allow for different sediment collection methods that yield different data.
  - For Habitat Condition 3 (Hydrology): adding criterion for mature forest cover based on canopy cover or percent hydrologically mature vegetation to subwatersheds within the forest production zone; for the road network density; and for tidally influenced areas.
  - For Habitat Condition 4 (Water Quality): adding turbidity and total suspended solids to the list of evaluated parameters; and revising the criteria to reflect changes that occur from the EPA and WDFW review of state water temperature criteria for salmonids.
  - For Habitat Condition 5 (Wetlands/Riparian Zone and Shoreline Vegetation/LWD): modifying the criteria to include LWD key piece data (in addition to total pieces); and to reflect conditions on non-forested lands.
  - For Habitat Condition 6 (Shoreline Condition and Floodplain Connectivity): adding criterion similar to that used by the Washington Conservation Commission for the Limiting Factors Analysis (length of stream with lost floodplain connectivity due to incision, roads, dikes, and flood protection with percentage breaks of <10%, 10 - 50%, and >50%; and lost wetted floodplain area with percentage breaks of <33%, 33 - 66%, >66%); and developing criterion to reflect conditions in areas without floodplains (such as the Everett coastal drainages).

- Futher distinguish between "intact" and "data gap" to indicate that no problems have been detected during scientific investigation or that there are no known problems because scientific investigation has not occurred.

- Application of additional performance criterion to the subwatersheds (e.g, as more data is about where bull trout spawn and rear, the temperature criterion can be more widely used).

- Evaluation of river mainstems separate from subwatersheds and evaluation of tributaries separate from rivers (e.g., in this report, the Lower Snohomish River is evaluated as part of the Marshland and French Creek subwatersheds).

- Separate evaluation of Allen and Quilceda creeks in the Snohomish River watershed and of the Elwell/Youngs creek complex in the lower mainstem Skykomish River subwatershed.

Habitat Conditions Definitions and Performance Criteria

Habitat Condition 1. Instream Artificial Barriers to Habitat

Explanation and Effect

Habitat access barriers include dams, tidegates, floodgates, pump stations, water diversions, poorly installed culverts, and hatchery fish screens. This habitat condition focuses on instream barriers in main channels and tributaries (specifically, culverts, weirs, dams, and pump stations). Habitat Condition 6, Shoreline Condition and Floodplain Connectivity, deals more directly with bank hardening and levees that may restrict access to off-channel habitat as well as inhibit channel migration.

In a subwatershed with fish passage barriers, a range of negative impacts can occur. Instream artificial barriers can eliminate or restrict juvenile and adult access to upstream rearing and spawning habitat. In some cases, migration of juveniles to estuarine habitats and other off-channel habitat can be inhibited. Low or reduced flows can exacerbate passage problems at artificial barriers, reduce areas of refuge from predation, and decrease the area and quality of food production for juveniles. Barriers can also restrict access to refuge habitat during high flow events.

Method for Selection and Application of Performance Criterion

The performance criterion for artificial barriers is from NOAA, 1996. The extent of habitat blocked for the "moderately degraded" and "degraded" classifications has been added, as well as the clarification "range of flows" for the "degraded" classification. In evaluating subwatersheds, reviewers made judgment calls about the significance of access restrictions with respect to both the productivity of the area where access is restricted and the degree of restriction at various flow levels. For example, in some subwatersheds where blocking culverts affect only small headwater creeks, an assessment of "moderately degraded" instead of "degraded" can be given.

Performance Criterion for Instream Artificial Barriers to Habitat

No.	Intact	Moderately Degraded	Degraded
1.1	Human-made structures allow upstream and downstream juvenile and adult fish passage at all flows.[6]	Human-made structures partially limit access by some species or life history stages at some flows, or to a minor portion of the subwatershed.	Human-made structures do not allow upstream and/or downstream fish passage at a range of flows, or multiple blockages limit access to a major portion of the subwatershed.

[6] From NOAA, 1996, with clarification

Habitat Condition 2. Sediment

Explanation and Effect

Land use practices have changed the delivery rate and composition of sediments entering the channel network throughout large portions of the Snohomish River basin. Landslides and mass wasting accelerate the delivery of sediments to waterbodies. Human-made structures can interfere with natural sediment transport and disconnection of feeder bluffs from the intertidal zone can slow down the delivery of sediments.

An altered sediment regime can negatively affect all life history stages of salmonids. For example, eggs can be smothered and fry entombed by fine sediments deposited in spawning beds. Sedimentation in pools reduces juvenile rearing and adult holding habitat. High levels of suspended sediment can cause gill abrasion and can reduce the availability of food and access to food for salmonid fry, juveniles, and smolts.

Method for Selection and Application of Performance Criteria

2.1 Embeddedness. Embeddedness is the degree by which gravel and larger particles (boulder, cobble, or rubble) are surrounded or covered by fine sediment (Armantrout, 1998). Excessive embeddedness can reduce egg-to-fry survival, rearing capacity for some salmonid species, and macro-invertebrate abundance and diversity. The performance criterion for embeddedness is adapted from NOAA, 1996.

2.2 Fine Sediment. These are the fine-grained particles (less than 0.85mm) within spawning gravels. Excessive fine sediment can reduce egg-to-fry survival, rearing capacity for some salmonid species, and macro-invertebrate abundance and diversity. This performance criterion is from Washington Forest Practices Board, 1997.

2.3 Actively eroding banks. Bank erosion is a natural process and contributes significant amounts of spawning-sized gravels to rivers and streams. Excessive bank erosion can indicate a system out of balance or degraded habitat conditions (e.g., excessive fine sediment in spawning gravel or aggradation of the channel bed). This criterion is adapted from NOAA, 1996 and applied to areas of active erosion below the ordinary high water mark.

2.4 Feeder bluffs. Feeder bluffs are natural sources of sediment delivery along the nearshore environment. This criterion is applied only within the estuary and along the Puget Sound nearshore. Evaluations for this criterion are based on the presence or absence of human-made structures that create discontinuity between feeder bluffs and the intertidal zone.

2.5 Sediment transport. Sediment transport is the process by which sediment is delivered, routed and stored in a natural system. The evaluation of each subwatershed on this criterion is based on the presence or absence of human-made structures that disrupt natural sediment transport processes.

Performance Criteria for Sediment

No.	Intact	Moderately Degraded	Degraded
2.1	Less than 20% embeddedness in spawning gravel.[7]	20-30% embeddedness in spawning gravel.	More than 30% embeddedness in spawning gravel.
2.2	Less than 12% fine sediment (under 0.85mm) in spawning gravels.[8]	12-17% fine sediment in spawning gravels.	More than 17% fine sediment in spawning gravels.
2.3	Less than 10% actively eroding bank. [9]	10-20% actively eroding bank.	More than 20% actively eroding bank.
2.4	More than 75% of feeder bluffs connected to intertidal zone.[10]	50-75% of feeder bluffs connected to intertidal zone.	Less than 50% of feeder bluffs connected to intertidal zone.
2.5	Human-made structures do not interfere with natural sediment transport.[11]	Human-made structures partially interfere with natural sediment transport.	Human-made structures substantially interfere with natural sediment transport.

[7] Adapted from NOAA, 1996
[8] From WFPB, 1997
[9] Adapted from NOAA, 1996
[10] Houghton, 2000
[11] Houghton, 2000

Habitat Condition 3. Hydrology

Explanation and Effect

This condition includes both base and peak flows. Baseflow is the portion of stream discharge that is derived from natural storage rather than directly from rainfall or snowmelt. Baseflow is controlled by groundwater flow from alluvial floodplains, wetlands, confined aquifers, alpine lakes, and glaciers. It can be negatively affected by high levels of impervious area, stream channelization, bank hardening, wetland fill and degradation, altered sediment regimes, and surface water and groundwater withdrawals. Peak flows result from precipitation (storm duration and intensity), snowmelt runoff, and watershed conditions. These affect the rate of groundwater infiltration and surface runoff. There is natural variability in the timing, frequency, and duration of peak flows. High levels of impervious area, increased interception and delivery of water due to road networks, truncation of the channel network (e.g., a side channel cut off by a levee), wetland fill and degradation, channelized streams, and hardened streambanks can result in peak flows that are of more destructive magnitude and duration than natural flows.

Altered hydrology (e.g., altered duration, timing, and magnitude) can negatively affect fresh water life history stages of salmonids. For example, low flows that result from watershed modification can reduce rearing and spawning areas, prevent access to rearing and spawning habitat, and diminish food production and transport. Increased peak flows can scour redds and also transport and deposit sediment in pools, thereby smothering eggs and alevins and reducing juvenile rearing and adult holding habitat.

Method for Selection and Application of Performance Criteria

3.1 Total Impervious Area. Total impervious area (TIA) is the sum of all roads, parking lots, rooftops, sidewalks, and other surfaces that cannot effectively absorb or infiltrate rainfall or snow melt. Increased basin imperviousness is well correlated with hydrologic changes (Dunne and Leopold, 1978; Brown, 1988; Booth and Jackson, 1994), degraded water quality (Klein, 1979), declines in physical habitat conditions (May et al., 1997; Shaver et al., 1995; and Schueler and Galli, 1992), and declines in the abundance and diversity of stream biota (May et al., 1997; Shaver et al., 1995; Klein, 1979; Steedman, 1988; and Schueler and Galli, 1992).

There is a continuum of effects as the amount of impervious area increases. For this report, the TIA thresholds selected for their impact on fish habitat are: less than 7% TIA ("intact"), 7 - 12% TIA ("moderately degraded"), and greater than 12% TIA ("degraded"). These thresholds are based on a summary of the literature reported in Spence et al., 1996. They cite numerous studies that document geomorphic, hydrologic, and biological effects that become evident between 7 - 12% TIA and substantial abover 12% TIA.

The two main shortcomings of TIA estimates are that they tend to undercount areas that have been compacted but not paved and they include impervious surfaces that may be infiltrated on site. Nevertheless, TIA is a valuable indicator of habitat conditions because it is well correlated with impacts to aquatic systems.

In this report, TIA is only applied as an indicator within urbanizing and rural subwatersheds located in the Puget lowlands and foothills. It is not applied in subwatersheds that have 50% or greater of their area east of the forest production zone boundary (federal, state and private forest lands) (see attached figure).[12] It should also be noted that the impacts of TIA vary with watershed size and location in the subwatershed. Given the scale of assessment, these variables are not included in the analysis. Where these factors are thought to have a significant influence, it is noted within individual subwatershed summaries. TIA values presented do not include open water. While precipitation falling on open water directly contributes to surface water runoff, this is not included in the TIA calculations because much of the literature on which correlations between TIA and habitat quality indicators were developed does not include open water.

The subwatershed TIA numbers presented in this report were generated by Snohomish County using Landsat satellite imagery (30m pixel resolution) (Purser and Simmonds, 2002). They evaluated 69 spectral reflectance classes developed by the Puget Sound Regional Synthesis Model (PRISM) project team and grouped these into nine land cover classes. Model validation is still underway. They performed an independent delineation of TIA on 1:24,000-scale digital aerial photography (1998 using three-foot pixel resolution and scaled to 1:6,000 in ArcView for digitization purposes) of 30 - 40 randomly selected polygons in each of five subwatersheds found throughout Snohomish County. Development of an error matrix is part of this project.

3.2 Annual hydrograph characteristics. In subwatersheds with stream flow gages or where hydrologic modeling efforts have been undertaken, peak flow, baseflow, and flow timing are compared to conditions within an undisturbed watershed of similar size, geology, climate, and geography. This criterion is from NOAA, 1996. This criterion is only applied if gage data are available for a subwatershed.

Forest canopy cover is not used as a basis for subwatershed assessment because thresholds have not yet been established.

Performance Criteria for Hydrology

No.	Intact	Moderately Degraded	Degraded
3.1	Total Impervious Area less than 7%. [13]	Total Impervious Area greater than or equal to 7% and less than 12%.	Total Impervious Area greater than 12%.
3.2	Annual hydrograph displays characteristics of baseflow, peak flow, and flow timing comparable to undisturbed watershed. [14]	Some evidence of reduced and/or altered baseflow, and/or peak flow, and/or flow timing.	Pronounced reductions in baseflow, and/or peak flow, and/or flow timing.

[12] The forest production zone delineates the boundary of current forested lands. It does not represent the extent of historically forested areas.
[13] From Spence, et al., 1996
[14] From NOAA, 1996

Forest Production Zone within the Snohomish River Basin (WRIA 7)

Snohomish & King Counties, Washington

Legend

River Basin

SubWatershed Boundary

County Boundary

Forest Production Zone

Snohomish County

PUBLIC WORKS
SURFACE WATER MANAGEMENT
(425) 388-3464

State Plane Zone 5601, NAD 83, Units Feet
Sources: Snohomish County 1:24K
County & City Boundaries, Basins
i:\pw\swm\proj\snoho\amls\forprod_8511.aml, 09/05/02, spwsxb

Habitat Condition 4. Water Quality

Explanation and Effect

Runoff from stormwater, construction, and agricultural activities transports pollutants to the rivers, streams, shorelines, and lakes of the Snohomish River basin, thereby degrading water quality. Removal of riparian canopies contributes to elevated water temperatures and lower dissolved oxygen in some waterbodies. Dissolved oxygen levels are often below state water quality standards in some waterbodies, while others have increased levels of toxic metals and organic chemicals that can affect ecosystem health.

Degraded water quality conditions negatively affect all freshwater life history stages of salmonids, particularly those from egg to smolt.

Method for Selection and Application of Performance Criteria

4.1. 303(d) list and state water quality standards. The U.S. Environmental Protection Agency (EPA) delegated the authority to list impaired waterbodies based on Section 303(d) of the federal Clean Water Act to the WDOE. These are waterbodies where one or more reaches do not meet federal and state water quality standards. The 303(d) listings are reach (segment)-specific, not subwatershed-specific. Not all waterbodies have been evaluated for inclusion on the 303(d) list. For some of these waterbodies, there is scientific data about water quality; for others, information has not yet been collected.

In evaluating information on water quality, the most recent 303(d) list and data in the scientific literature were reviewed. If a subwatershed has one segment that is on the 303(d) list or has state water quality violations for temperature, dissolved oxygen, pH, nutrients or toxic chemicals (metals or organic chemicals), then the subwatershed is characterized as "moderately degraded".[15, 16] If a subwatershed has more than one segment that is on the 303(d) list for one of these water quality parameters, or one segment that is on the 303(d) list for at least two of these water quality parameters, or if two or more water quality parameters do not currently meet state standards, then the subwatershed is characterized as "degraded". If the only available water quality data are from an old 303(d) list or from old references, then the assessment is "data gap".

4.2 Sediment Quality Standards. In 1991, the WDOE promulgated sediment management standards (Washington Administrative Code, Chapter 173.204) for sediments in marine and estuarine waterbodies. (There are no standards for freshwater sediments in Washington.) These standards indicate when one or more chemicals are found at a level that is detrimental to marine life. "Detrimental" includes both acute (short-term) and chronic (long-term) impacts. The sediment management standards contain two types of numbers: numeric criteria for sediment

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[15] Nutrients were selected because high levels can reduce dissolved oxygen levels in a waterbody or promote excessive plant growth that can also reduce dissolved oxygen levels.

[16] Fecal coliform bacteria counts that exceed water quality standards often place a waterbody on the 303(d) list. High fecal coliform counts are a public health threat, but it is not known if they are a threat for fish. For this report, fecal coliform data are not used to assess water quality, although they are mentioned in the narrative where available.

quality and maximum cleanup level (MCUL). These standards are based on bioassays of benthic invertebrates, but the resulting data has been extrapolated to fish. Although salmonids do not live in the sediments of marine and estuarine waterbodies, toxic chemicals in the sediments are released into the water column where salmonids may become exposed to them. Salmonids are also exposed to toxic chemicals through the food web. Toxic chemicals that are present in the tissues of benthic invertebrates and other salmonid prey are taken up by salmonids at even higher concentrations. Therefore, sediment quality can affect water quality and salmonids.

In evaluating information on sediment quality in the marine and estuarine subwatersheds, data on levels of chemical contaminants are compared with the numeric criteria for those chemicals. If sediment quality in a subwatershed meets the numeric criteria, then the subwatershed is categorized as "intact". If sediment quality exceeds the numeric criteria for one or more chemical contaminants but meets the MCUL, then the sediment is moderately detrimental to marine life and the subwatershed is categorized as "moderately degraded". If sediment quality exceeds the MCUL for one or more chemical contaminants, then the sediment is very detrimental to marine life and therefore the subwatershed is categorized as "degraded".

4.3 Salmonid temperature requirements. State water quality standards for temperature pertain to discrete time points, not occurrences over a period of time. These standards are not specific to salmonid species or to particular life stages of salmonids. Performance criterion 4.3 supplements 4.1 by focusing on surface water temperatures within the ranges preferred by salmonid species in their respective habitats and life stages, and by focusing on average maximum temperature over a seven-day period. Salmonids can survive temperatures that exceed state standards if the elevated temperature remains below the lethal threshold and only occurs for a short period of time before declining into the preferred range over a longer time.

The scientific literature indicates that 10.0 - 13.9º C (50 - 57º F) is the preferred temperature range for salmonid spawning and freshwater rearing for species other than bull trout and that 10.0 - 15.5º C (50 - 60º F) is the preferred temperature range for rearing in estuaries. Therefore, subwatersheds with waterbodies in these temperature ranges are categorized as "intact" for water quality. The temperature ranges in the "moderately degraded" and "degraded" categories are based on references in the scientific literature where moderate or more severe physiological effects occur (e.g., altered growth, swimming speed, health, and reproductive success) at temperatures where salmonids survive but do not thrive.

4.4 Bull trout temperature requirements. Bull trout prefer colder water than other salmonids. Performance criterion 4.4 is based on known temperature requirements for bull trout spawning, incubation, rearing, and foraging. The ideal temperature for spawning and incubation is less than 6º C (42.8º F). The ideal temperature for rearing and foraging is less than 10º C (50º F). Many waterbodies, including some headwaters areas, have temperatures that are naturally higher than these requirements. The EPA has asked WDOE to review state water temperature criteria for fish, including bull trout, and to revise these standards where appropriate. As the WDOE recommendations will be available after the publication of this report, the analysis of water quality is based on the temperature requirement information that is currently available.

The performance criterion for bull trout temperature requirements is applied only to those subwatersheds where bull trout are known to spawn, (i.e., North Fork Skykomish River and Foss River). As more information becomes available about where bull trout spawners or redds are located, performance criterion 4.4 or revised state standards could be applied to more subwatersheds.

Performance Criteria for Water Quality

No.	Intact	Moderately Degraded	Degraded
4.1	No 303(d) listed segments or no violations of state and federal water quality standards for temperature, dissolved oxygen, pH, nutrients, or toxic chemicals.[17]	One 303(d) listed segment or one water quality parameter that does not currently meet state and federal water quality standards for temperature, dissolved oxygen, pH, nutrients, or toxic chemicals.	More than one 303(d) listed segment or, one segment listed for more than one water quality parameter or, more than one water quality parameter that does not currently meet state and federal water quality standards for temperature, dissolved oxygen, pH, nutrients, or toxic chemicals.
4.2	Sediment quality meets state Sediment Quality Standards (SQS) (estuarine and marine subwatersheds only).[18]	Sediment quality meets state Maximum Cleanup Level (MCUL), but has some exceedances of Sediment Quality Standards (SQS) (estuarine and marine subwatersheds only).	Sediment quality does not meet state Maximum Cleanup Level (MCUL) for one or more contaminants (estuarine and marine subwatersheds only).
4.3	7-day moving average of daily maximums: • Less than 13.9°C (50-57°F) in spawning and freshwater rearing areas; • Less than 15.5°C (60°F) in estuary.[19]	7-day moving average of daily maximums: • 13.9-15.5°C (57-60°F) in spawning areas; • 13.9-17.8 °C (57-64°F) in rearing areas.	7-day moving average of daily maximums: • Greater than 15.5°C (60°F) in spawning areas; • Greater than 17.8 °C (64°F) in rearing areas.
4.4	• Less than 6.0°C (42.8°F) in bull trout spawning and incubation habitat. • Less than 10°C (50°F) in freshwater rearing/foraging habitat for bull trout.[20, 21]	• Greater than 6.0°C (42.8°F) but less than 10.0°C (50°F) in bull trout spawning and incubation habitat. • Greater than 10°C (50°F) but less than 14°C (57.2°F) in freshwater rearing/ foraging habitat for bull trout.	• Greater than 10.0°C (50°F) in bull trout spawning and incubation habitat • Greater than 14°C (57.2°F) in freshwater rearing/ foraging habitat for bull trout.

[17] From NOAA, 1996
[18] Washington Administrative Code, Chapter 173.204, WDOE (1991)
[19] From Bjornn, T. and D. Reiser, 1991
[20] Spence, et. al., 1996
[21] Rieman and McIntyre, 1993

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/Large Woody Debris (LWD)

Explanation and Effect

Wetlands provide an important salmonid rearing habitat function and have a major role in basin ground and surface water hydrology, water quality, nutrient cycling, and biotic diversity. Changes in land use (from forestry and agriculture to residential, commercial, and infrastructure) and practices in forestry, agriculture, and construction have degraded riparian areas and wetlands in the developed areas of the Snohomish River basin. Loss of wetlands is pervasive throughout the basin. This affects the entire food chain processes and interrupts hydrologic interactions and nutrient cycling functions.

Riparian area and wetland degradation or loss can negatively affect fresh water and estuarine life history stages of salmonids and reduce biological diversity. For example, loss of riparian and shoreline vegetation results in decreased shading and cover, nutrient input from litter fall, bank stability, recruitment of large woody debris (LWD) into streams and rivers and increased bank erosion. The absence of instream LWD results in reduced sediment and nutrient retention, fewer pools, less refuge and rearing habitat, and overall loss of in-channel and side-channel structural complexity and biological diversity.

Method for Selection and Application of Performance Criteria

5.1 Shoreline buffer. Riparian buffers play an integral role in defining temperature regimes, nutrient cycling, coarse and large woody debris contributions, and forage relationships. This criterion is from NOAA, 1996. A width of one site potential tree (SPT) is used to define the physical limits of the riparian buffer. A SPT is defined as the height that a tree could potentially grow to on a particular site. The buffer will vary depending on the SPT height.

5.2 Wetland, estuarine, and nearshore reserves. Simplified from NOAA 1996, the criterion describes an ecological system that provides adequate shade, opportunity for LWD recruitment, connectivity between upland and aquatic environments, buffers from human use impacts, and/or refugia for sensitive aquatic species.

5.3 LWD frequency. Derived from WDFW and WWTT, 1997, and WFPB, 1997, this criterion scales the total number of pieces of LWD to the bankfull channel width.

5.4 Average stem diameter. Adapted from Point-No-Point Treaty Council and WDFW, 1999, the criterion address the average stem diameter from riparian forests, not single pieces. The measure is a surrogate for the ability of the riparian forest to deliver LWD to a system, and is used to evaluate riverine conditions.

Performance Criteria for Wetlands/Riparian Zone and Shoreline Vegetation/LWD

No.	Intact	Moderately Degraded	Degraded
5.1	More than 80% of stream shoreline has buffer width greater than one site potential tree height.[22]	70-80% of stream shoreline has buffer width greater than one site potential tree height.	Less than 70% of stream shoreline has buffer width greater than one site potential tree height.
5.2	More than 80% of pre-development (mid-19th century) wetland, estuarine, and nearshore reserves are intact.[23, 24]	50-80% of pre-development (mid-19th century) wetland, estuarine, and nearshore reserves are intact.	Less than 50% of pre-development (mid-19th century) wetland, estuarine, and nearshore reserves are intact.
5.3	• 2-4 pieces LWD/channel width greater than 20m wide.[25, 26] • More than 0.5 piece LWD/channel width 10-20m wide. • More than 0.3 piece LWD/channel width less than 10m wide.	• 1-2 pieces LWD/channel width greater than 20m wide. • 0.2-0.5 piece LWD/channel width 10-20m wide. • 0.15-0.3 piece LWD/channel width less than 10m wide.	• Less than 1 piece LWD/channel width greater than 20m wide. • Less than 0.2 piece LWD/channel width 10-20m wide. • Less than 0.15 piece LWD/channel width less than 10m wide.
5.4	Average stem diameter greater than 50cm dbh (diameter at breast height).[27]	Average stem diameter 30-50cm dbh.	Average stem diameter less than 30cm dbh.

[22] From NOAA, 1996
[23] Intact reserves are defined as contiguous areas within the riparian area (channel migration zone or ordinary high water mark, where more applicable, plus one site potential tree height horizontal distance) that meet potential natural composition, mean stem diameter, and canopy cover standards.
[24] From NOAA, 1996
[25] From WDFW and Western Washington Treaty Tribes, 1997 and WFPB, 1997
[26] Criterion applies to stream or river channels only. No standards exist for lakes, estuarine, or tidal areas.
[27] From Point No Point Treaty Council and WDFW, 1999

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity

Explanation and Effect

River and stream channels in the Snohomish River basin have been significantly altered since 1864 when Dr. H.A. Smith constructed a dike to isolate 64 acres of tidal marsh on Smith Island. Most channel alterations since that time have been intentional for the purpose of flood control, stormwater conveyance, floodplain conversion to agricultural production, navigation, erosion control, bank stabilization, and protection of transportation corridors. Physical modifications to river channels result from many types of structures including dikes, levees, revetments, berms, groins, deflectors, spurs, bridges, roads, railroads, floodplain fill, bioengineering techniques, and concrete structures. These structures all vary greatly in their size, length, height, channel encroachment, life expectancy, cost, and ecological impacts. Dredging activities also result in channel modifications.

The physical changes of channelization and bank hardening are similar in that they typically alter one or more of the interdependent hydraulic variables of channel length, width, depth, velocity, slope, roughness, and sediment size. Channelization of a river results from the persistent alterations to these hydraulic variables. Physical and biological impacts associated with bank stabilization projects are typically detrimental to salmonid habitat and populations. Direct habitat loss occurs when channel length is shortened; side channels, sloughs, blind channels and other waterbodies are cut off from the main channel; and high flows are contained in the channel rather than allowed to spread across the floodplain. Habitat quality is diminished by bank hardening projects that reduce or eliminate riparian cover; reduce the entry of large woody material into the channel; remove large woody material from the channel; eliminate undercut banks; alter the physical characteristics of width, depth, velocity, slope, roughness, and sediment size within the channel; and reduce invertebrate production.

Method for Selection and Application of Performance Criterion

Several habitat condition indicators were originally considered for this section. The initial review of the information available for each of the subwatersheds revealed that shoreline hardening and overwater structure data is most applicable to this habitat condition and generally available. Data supporting other habitat condition indicators is less available and less consistent for application to all the subwatersheds.

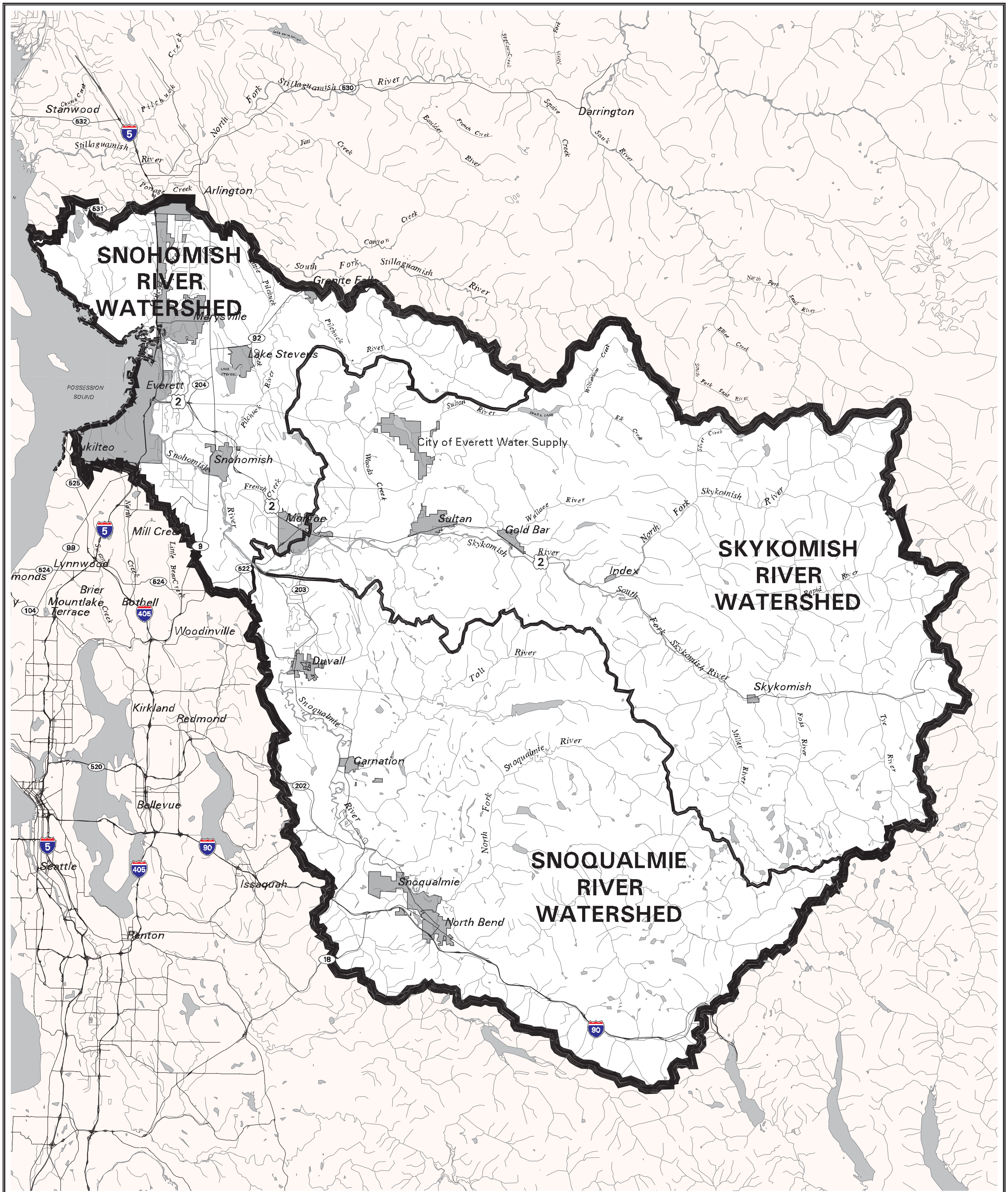
Performance Criterion for Shoreline Condition and Floodplain Connectivity

No.	Intact	Moderately Degraded	Degraded
6.1	Shoreline hardening or overwater structures affect less than 10% of shorelines.[28]	Shoreline hardening or overwater structures affect 10-20% of shorelines.	Shoreline hardening or overwater structures affect more than 20% of shorelines.

[28] From NOAA, 1996. Consistent with streambank stability criterion in Habitat Condition 2.

Watershed Summaries

The subwatershed assessments are summarized in the following tables. They are organized by watershed (Skykomish River, Snoqualmie River, and Snohomish River) and are preceded by a map. Details of each subwatershed assessment follow the summaries and are also organized by watershed. Where available, river miles associated with each subwatershed are listed.



Snohomish River Basin Watersheds

Basin Boundary

Watershed Boundary

Rivers

Roads

Nearshore Boundary

Cities

0 2 4 6 8 10

miles

Snohomish County

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State Plane Zone 5601, NAD 83, Units Feet
Sources: ESA Basins, USGS 1:100k Hydrography.

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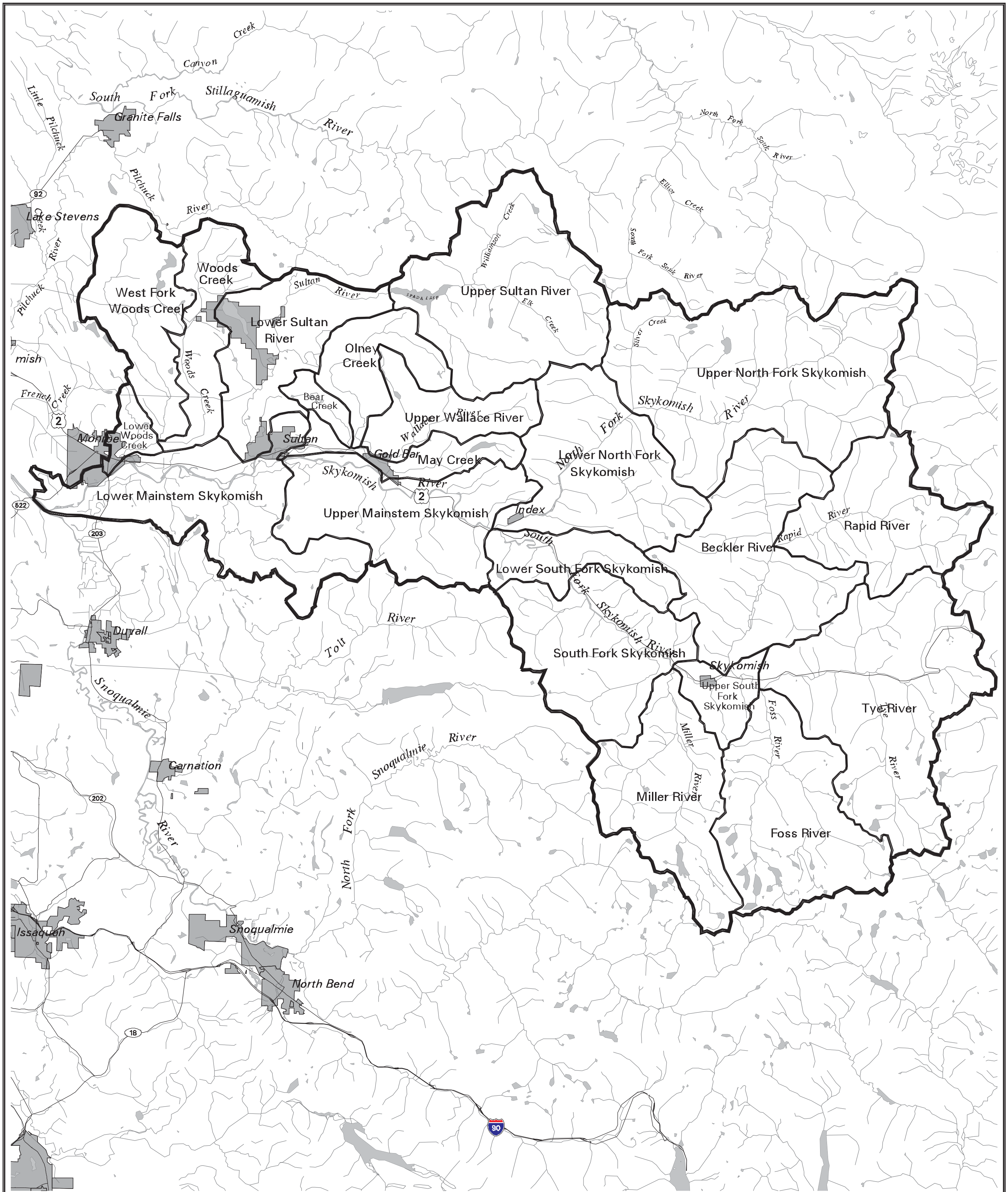

Skykomish River Watershed & Subwatersheds

- Skykomish River Watershed Boundary
- Subwatershed Boundary
- Rivers
- Roads
- Cities

N W E S

0 2 4

miles

Snohomish County

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State Plane Zone 5601, NAD 83, Units Feet
Sources: Snohomish County 1:24k Cities, ESA Basins
King County 1:24k Roads, Cities; USGS 1:100k Hydrography.
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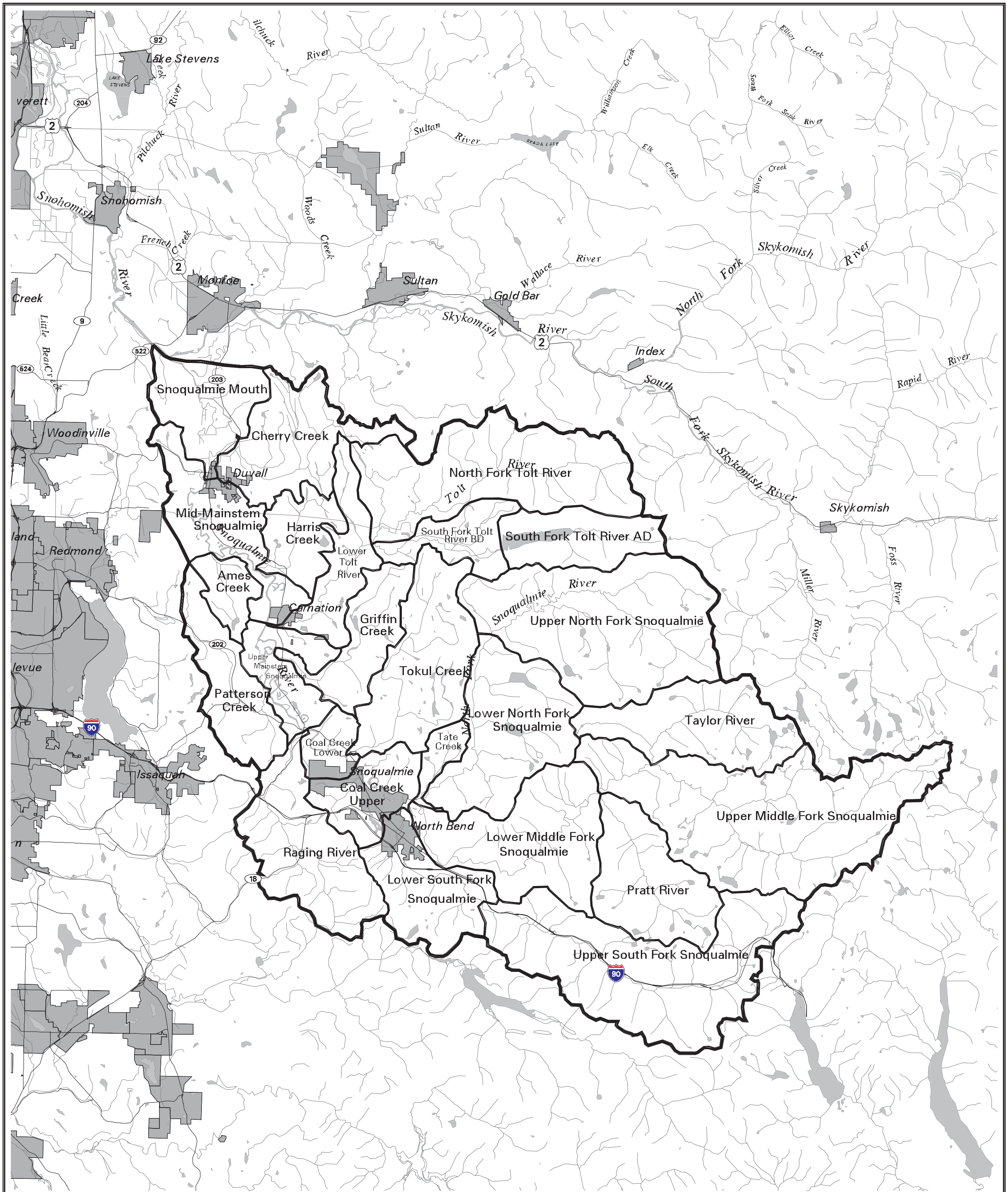
Skykomish River Watershed – Habitat Conditions Review Summary

Subwatershed	Acres	Instream Artificial Barriers to Habitat	Sediment	Hydrology	Water Quality	Wetlands/Riparian Zone & Shoreline Vegetation/LWD	Shoreline Condition & Floodplain Connectivity
Bear Creek	3,102	●	**DG**	**DG**	**DG**	**DG**	**DG**
Beckler River	38,179	○	●	**DG**	◒	●	○
Foss River	35,459	○	○	**DG**	○	◒	○
May Creek/Lower Wallace River	8,614	●	**DG**	**DG**	◒	**DG**	**DG**
Miller River	29,335	○	◒	○	○	**DG**	○
Olney Creek	12,822	**DG**	**DG**	**DG**	**DG**	**DG**	**DG**
Rapid River	26,451	○	●	**DG**	○	**DG**	**DG**
Skykomish River - Lower Mainstem	35,577	●	**DG**	◒	●	●	◒
Skykomish River - Upper Mainstem	31,605	●	**DG**	○	◒	●	●
Skykomish River - Lower North Fork	33,106	◒	**DG**	**DG**	**DG**	●	●
Skykomish River - Upper North Fork	60,770	○	◒	**DG**	**DG**	◒	◒
Skykomish River - Lower South Fork	12,803	◒	**DG**	**DG**	○	**DG**	●
Skykomish River - South Fork	30,312	◒	**DG**	○	◒	◒	●
Skykomish River - Upper South Fork	7,092	◒	**DG**	**DG**	◒	◒	●
Sultan River - Lower	23,584	●	●	●	○	○	○
Sultan River – Upper	43,589	●	**DG**	○	○	**DG**	**DG**
Tye River	51,772	○	**DG**	**DG**	◒	**DG**	**DG**
Wallace River - Upper	13,519	●	**DG**	○	**DG**	◒	**DG**
Woods Creek	15,690	●	●	○	**DG**	**DG**	**DG**
Woods Creek - Lower	3,670	◒	●	●	◒	**DG**	**DG**
Woods Creek - West Fork	21,920	●	●	○	**DG**	**DG**	**DG**

Legend: ○ — Intact ◒ — Moderately Degraded ● — Degraded **DG** — Data Gap



Snoqualmie River Watershed & Subwatersheds

- Snoqualmie River Watershed Boundary
- Subwatershed Boundary
- Rivers
- Roads
- Cities

0 2 4

miles

Snohomish County

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State Plane Zone 5601, NAD 83, Units Feet
Sources: Snohomish County 1:24k Cities, ESA Basins
King County 1:24k Roads, Cities; USGS 1:100k Hydrography.
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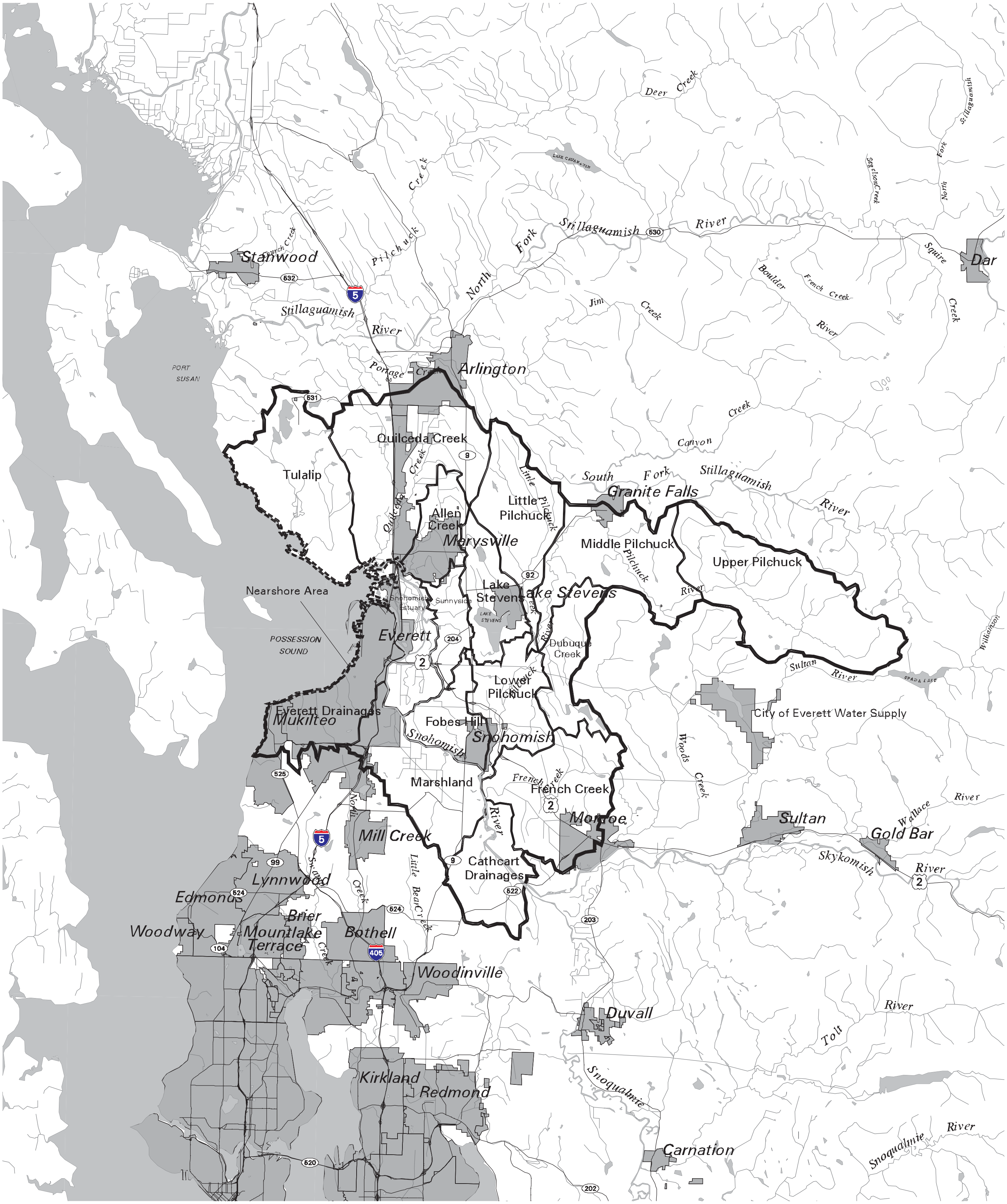
Snoqualmie River Watershed – Habitat Conditions Review Summary

Subwatershed	Acres	Instream Artificial Barriers to Habitat	Sediment	Hydrology	Water Quality	Wetlands/Riparian Zone & Shoreline Vegetation/LWD	Shoreline Condition & Floodplain Connectivity
Ames Creek	4,941	●	DG	○	DG	●	◒
Cherry Creek	17,536	●	DG	○	●	●	●
Coal Creek - Lower	4,538	DG	DG	◒	●	●	●
Coal Creek - Upper	9,733	DG	DG	◒	DG	●	DG
Griffin Creek	11,257	●	●	DG	○	◒	◒
Harris Creek	8,626	●	DG	○	DG	●	◒
Patterson Creek	13,220	●	●	○	●	●	DG
Pratt River	18,094	DG	DG	DG	DG	○	○
Raging River	20,987	●	◒	DG	DG	●	●
Snoqualmie River - Mouth	12,814	●	DG	○	●	●	●
Snoqualmie River - Mid-Mainstem	15,493	●	◒	◒	●	●	●
Snoqualmie River - Upper Mainstem	9,256	●	◒	◒	●	●	●
Snoqualmie River - Lower South Fork	15,079	DG	DG	◒	●	●	◒
Snoqualmie River - Upper South Fork	40,334	DG	DG	DG	●	◒	◒
Snoqualmie River - Lower Middle Fork	24,006	◒	DG	DG	DG	●	◒
Snoqualmie River - Upper Middle Fork	47,800	DG	DG	DG	DG	○	○
Snoqualmie River - Lower North Fork	23,313	DG	DG	DG	DG	DG	◒
Snoqualmie River - Upper North Fork	39,633	DG	DG	DG	DG	DG	DG
Tate Creek	3,028	DG	DG	DG	DG	●	DG
Taylor River	19,551	DG	DG	DG	DG	◒	○
Tokul Creek	21,704	●	◒	DG	○	○	○
Tolt River - Lower	10,606	○	◒	●	○	DG	●
Tolt River - North Fork	32,596	◒	DG	○	○	●	○
Tolt River - South Fork Above Dam	11,897	◒	●	DG	DG	●	DG
Tolt River - South Fork Below Dam	8,190	○	●	●	○	●	○

Legend: ○ — Intact ◒ — Moderately Degraded ● — Degraded **DG** — Data Gap



Snohomish River Watershed & Subwatersheds

Snohomish River Watershed Boundary

Subwatershed Boundary

Rivers

Roads

Nearshore Boundary

Cities

0 2 4

miles

Snohomish County

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State Plane Zone 5601, NAD 83, Units Feet
Sources: Snohomish County 1:24k Cities, ESA Basins
King County 1:24k Roads, Cities; USGS 1:100k Hydrography.
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Snohomish River Watershed – Habitat Conditions Review Summary

Subwatershed	Acres	Instream Artificial Barriers to Habitat	Sediment	Hydrology	Water Quality	Wetlands/Riparian Zone & Shoreline Vegetation/LWD	Shoreline Condition & Floodplain Connectivity
Cathcart Creek	10,164	●	DG	●	●	●	DG
Dubuque Creek	8,160	DG	DG	◒	●	●	DG
Everett Coastal Drainages[29]	12,239	DG	DG	●	◒	●	○
Fobes Hill	6,785	●	●	●	DG	●	●
French Creek	17,909	●	●	●	●	●	●
Lake Stevens Drainages	8,511	◒	●	●	◒	●	◒
Little Pilchuck Creek	13,524	DG	DG	◒	DG	●	DG
Marshland Drainages	14,851	●	●	●	●	●	●
Pilchuck River - Lower	9,949	◒	◒	◒	●	●	●
Pilchuck River - Middle	17,547	◒	DG	◒	●	●	◒
Pilchuck River - Upper	26,156	●	DG	DG	○	◒	◒
Quilceda/Allen Creek	25,687	◒	●	●	●	●	●
Sunnyside Drainages	4,777	●	DG	●	DG	●	DG
Tulalip and Battle Creeks	20,078	●	●	○	○	●	DG
Nearshore Area		○	●	DG	●	●	●
Snohomish River - Estuary	9,131	●	●	●	●	●	●

Legend: ○ — Intact ◒ — Moderately Degraded ● — Degraded **DG** — Data Gap

[29] This subwatershed consists of nine small drainages that vary in terms of habitat condition. For this summary page, the assessment identified occurs most frequently. A table of specific habitat conditions included with the assessment.

Skykomish River Watershed Habitat Conditions

Bear Creek (headwaters – May Creek RM 4.1)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
The WDFW Fish Passage Culvert Database identifies three culverts that are barriers to passage (WDFW, 2002).

Habitat Condition 2. Sediment
Data Gap

Habitat Condition 3. Hydrology
Data Gap

Habitat Condition 4. Water Quality
Data Gap

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Data Gap

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Data Gap

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	X
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area			Data gap	X
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap	X	6.1	Shoreline hardening and overwater structures	
				Data gap	X

Beckler River (headwaters – S. Fork Skykomish RM 17.1)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Intact
No human-made barriers to anadromous fish passage are known to exist. Upstream fish passage ends at river mile (RM) 11.8—the natural, 12-foot migration barrier at Sunset Falls on the South Fork Skykomish River that historically excluded anadromous species from the Beckler River subwatershed. Since 1958, migration has been possible due to a trap and haul facility at Sunset Falls.

Habitat Condition 2. Sediment
Degraded
Wissmar and Beer (1994) assessed streambanks in the Beckler River subwatershed and found considerable variability between drainage areas. Depending on the segment, they found the length of unstable streambanks to vary between 38% and 100%. Nawa (1994) also considered streambank instability in tributaries as highly variable and related to geologic condition (e.g., colluvium and alluvium). Generally, streambank conditions fall into a "degraded" condition.

Fine sediment levels in the Beckler River vary by reach and by year. Sediment sampling has not consistently identified what percentage of the sample particle sizes are 0.85mm. However, surface fines measured in the late 1990s have ranged from 0 - 25%, which falls into the "intact" and "moderately degraded" categories. Sediment sampling, using methods described by Wolman (1954), was conducted on the Beckler River (n = 27). Surface fines (less than 2mm) ranged from 0% - 25% with an average of seven percent, suggesting fine sediment levels are "intact". Percent fines less than six mm are usually undersampled using the Wolman method and should represent a higher percentage. Pebble counts conducted at RM 9.5 decreased from 25% to 11% fines between 1996 and 1998. Substrate composition reported by Cascade Environmental (1997) also suggested fines (e.g., sands) represented, on average, less than five percent of the substrate.

In 1996, effectiveness monitoring was conducted on embeddedness at three locations on the upper Beckler River. All measurements fell between not embedded and moderately embedded.

Sediment supply estimates provide information on the temporal dynamics of any given watershed (Nelson, 1998). Wissmar and Beer (1994) reported sediment volumes of 15 m^3/km^2/year for the upper Beckler River, and four m^3/km^2/year for the lower Beckler River. These rates are relatively low when compared to those estimated by Paulson (1997). She found natural background rates in nine fifth field watersheds in the Skagit River basin vary between 48 and 1,127 m^3/km^2/year. The watersheds with the higher background rates were watersheds dominated by either glacial deposits or low-grade metamorphic rock.

Habitat Condition 3. Hydrology
Data Gap
There are currently no discharge gages operating in the Beckler River subwatershed. Forty-five percent of the subwatershed is in the rain-on-snow zone (USFS, 1999). There is some evidence

of altered peak flow characteristics resulting from past timber harvesting and road building in the rain-on-snow zone (USFS, 1995a; USFS, 1999).

Habitat Condition 4. Water Quality
Moderately Degraded
Surveys in 1996 found rearing temperatures exceeding 14º C (USFS, 1999). Point measurements in the Beckler River have reached as high as 23º C in July (Tulalip Tribes, 1994). The Tulalip Tribes have also documented temperatures in the lower Beckler River in excess of 15º C in August 1996 and 15º C in July of 1998 (Tulalip Tribes, unpublished data). It is unknown to what extent these temperatures reflect human impacts (i.e., clearing of the riparian forest) or natural conditions.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
The Beckler subwatershed has a low frequency of LWD compared to undisturbed regions (USFS, 1995a; USFS, 1999). This is likely due to changes in riparian forest composition, past wood removal, and the 1990 flood (USFS, 1995a; USFS, 1999). In a 1996 stream survey, less than 0.1 piece of LWD/channel width of greater than 20m (8.1 pieces of LWD/mile) were found in the lower Beckler River. Less than 0.3 pieces of LWD/channel width of between 10 and 20 meters (21.8 pieces of LWD/mile) were found in the upper Beckler River. These are "degraded" conditions.

Effectiveness monitoring between 1996 and 1998 in the upper Beckler reported 1.5 pieces of LWD/channel width of greater than 20m (167 pieces of LWD/mile), which is "moderately degraded". Large woody debris included pieces greater than 20cm in diameter and greater than two meters in length.

Wissmar and Beer (1994) reported LWD frequencies in the upper Beckler of 1.1 pieces of LWD/channel width of greater than 20m (7.9 pieces/100 meters). Large woody debris frequencies in tributaries were reported by Nawa (1994). He found LWD frequencies to vary in six major tributaries of the Beckler River, ranging from 5 pieces/100 meters to 28 pieces/100 meters.

Removal of LWD has caused a concomitant decrease in pool density between 1980 and 1991 (USFS, 1992).

Overall, within the Beckler River subwatershed, 38% of the riparian zone consisted of mature riparian vegetation (USFS, 1995a). However, the trees that are present have low LWD value and recruitment potential.

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Intact
Several sections of the Beckler Road and associated riprap constrain the river, however the majority of the subwatershed has no development in the floodplain or riparian areas, and channels have remained connected to associated off-channel and overflow channels. (USFS, 1999).

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	X
2.1	Embeddedness	X	4.4	Bull trout temperature requirement	
2.2	Fine sediment	X		Data gap	
2.3	Actively eroding banks	X	5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap		5.3	Large woody debris	X
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area			Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap	X	6.1	Shoreline hardening and overwater structures	X
				Data gap	

Foss River (headwaters – S. Fork Skykomish RM 19.8)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Intact
No human-made barriers to anadromous fish passage are known to exist (USFS, 2000).

Habitat Condition 2. Sediment
Intact
No sediment budgets have been estimated for this watershed and no bedload or suspended load samples are known to have been collected. However, it is likely that the natural sediment regime is "intact". Approximately 77% of this watershed is in the Alpine Lakes Wilderness, no timber harvest has occurred in the remaining forest lands since 1990, road densities are low (0.5 miles/square mile), and inspection of aerial photography shows few mass failures. Based on these characteristics, the USFS has assumed that current sediment delivery rates to channels approximate natural background delivery rates (USFS, 2000).

Streambank condition was observed during spawning ground surveys conducted between 1994 and 1999 on the Foss River and determined to be "intact" (Nelson, 2002).

Habitat Condition 3. Hydrology
Data Gap
There are neither active nor past discharge gages in the Foss River subwatershed. Based on lack of empirical data, hydrology is categorized as a "data gap" for this subwatershed. However, since 77% of the watershed is protected in a Wilderness designation and there are few roads area outside the wilderness boundary, peak flow, baseflow, and flow timing characteristics are likely to be comparable to an undisturbed watershed of similar size (USFS, 2000).

Habitat Condition 4. Water Quality
Intact
The east fork of the Foss River is one of the known bull trout spawning areas in the Snohomish River basin. Temperature sampling (monthly 1994 - 1999) in the mouth of the Foss River indicates temperatures in the "intact" range for salmonids. Average temperatures from May to September were 8.7º C and for November through May were 4.9º C. These data indicate temperatures are within a suitable range for all salmonids. Temperature data collected for bull trout spawning and rearing areas in 2001-02 were in the "intact" range (Tulalip Tribes, unpublished data). Approximately 77% of the subwatershed is protected as a part of the Alpine Lakes Wilderness, where logging has not occurred since 1990 and overall road levels are low. It is likely that current temperatures approximate natural background levels.

The Foss River does not appear on the current 303(d) list for temperature or chemical contamination/nutrient standards. No known water samples have been analyzed for nutrients or other contaminants.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Moderately Degraded
Seventy-seven percent of the Foss River subwatershed lies within the Alpine Lakes Wilderness. The mainstem is heavily forested with mixed conifer and deciduous trees. One-third of the mainstem, near the forks, is mixed early seral (Savery, in prep.). On average, stem diameter is estimated to be between 30 - 50cm dbh. The valley of east fork of the Foss River has been harvested in the past, leaving a riparian corridor that ranges in width and stand age. The lower one-fourth of the east fork flows through early seral mixed deciduous and conifer forest with stem diameter estimated at less than or equal to 30cm dbh. The upper three-quarters of the east fork Foss River flows through a riparian corridor that ranges in width from approximately 30 feet to over 100 feet. Average stem diameter is estimated to range from 30 - 50cm dbh. The west fork Foss joins the east fork in a mixed deciduous and conifer forest that is disturbed from the river shifting in the valley. The west fork Foss River valley has been logged and the riparian corridor resembles that of the east fork.

Generally, the Foss River falls into the category of “moderately degraded”. The riparian zone is highly likely to recover and provide adequate LWD in the future. The Forest Service describes the existing riparian reserve network in the Foss River subwatershed as providing adequate shade, recruitment of large woody debris, and habitat protection and connectivity (USFS, 2000).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Intact
The lack of development or management in the floodplain or riparian areas along the mainstem has allowed the mainstem channel to stay connected with its floodplain (USFS, 2000).

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	X
2.1	Embeddedness		4.4	Bull trout temperature requirement	X
2.2	Fine sediment			Data gap	
2.3	Actively eroding banks	X	5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	X
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap		5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area			Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap	X	6.1	Shoreline hardening and overwater structures	X
				Data gap	

May Creek/Lower Wallace River (headwaters – Mainstem Skykomish RM 15.2)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
A weir for the Wallace Hatchery blocks access to May Creek from approximately June 1 through October for all species except steelhead, bull trout, and cutthroat trout. Adult chinook are placed upstream of the weir. Coho and chum salmon gain access when the seasonal weir is removed (Kraemer, 2002). There is one barrier culvert and five culverts with unknown passage status (WDFW, 2002).

Habitat Condition 2. Sediment
Data Gap
Wallace River sediment loads have been calculated to approximate a total sediment load of 2,000 tons/year, bedload is 200 tons/year, and suspended sediment is 1,800 tons/year (Dunne, 1979).

Habitat Condition 3. Hydrology
Data Gap

Habitat Condition 4. Water Quality
Moderately Degraded
Based on data collected by WDFW at Wallace Hatchery (28N, 09E, 31), the Wallace River is on the 303(d) list for temperature (WDOE, 1998).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Data Gap
Thirty-seven percent of the riparian reserve in the National Forest (mostly within the upper subwatershed) is in non-forested conditions (USFS, 1997).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Data Gap
There is significant shoreline hardening along the Wallace River through the City of Gold Bar, but the percent of bank armoring has not been quantified. The Wallace River and the Skykomish River, which share a floodplain, have been disconnected by Highway 2 and the Burlington Northern Santa Fe (BNSF) Railroad.

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	X
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area			Data gap	X
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap	X	6.1	Shoreline hardening and overwater structures	
				Data gap	X

Miller River (headwaters – S. Fork Skykomish RM 14.1)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Intact
No human-made barriers to anadromous fish passage are known to exist (USFS, 2000).

Habitat Condition 2. Sediment
Moderately Degraded
Stream bank condition was observed during spawning ground surveys conducted between 1994 and 1999 on the lower 3.5 miles of the Miller River and determined to be "moderately degraded" (Nelson, 2002). The river channel is reported to be higher in elevation than the streambanks and the channel is widening as a result.

No sediment budgets have been estimated for this watershed and no bedload or suspended load samples are known to have been collected. Approximately 79% of this watershed is in the Alpine Lakes Wilderness, no timber harvests have occurred in the remaining forestlands since 1990, road densities are low (0.5 miles/square mile), and inspection of aerial photography shows few mass failures. Based on these characteristics, the USFS has assumed that current sediment delivery rates to channels approximate natural background delivery rates (USFS, 2000).

Habitat Condition 3. Hydrology
Intact
The Forest Service has made a determination that peak flow, baseflow, and flow timing characteristics are comparable to an undisturbed watershed of similar size based on the high level of the subwatershed in a Wilderness designation (USFS, 2000).

Habitat Condition 4. Water Quality
Intact
The Miller River is not on the 303(d) list for temperature, nutrients, or chemical pollutants. The Tulalip Tribes collected seasonal stream temperatures in the mouth of the Miller River (RM 0.1) from 1994 - 1999. Mean values of annual dry season temperatures ranged from 9.8 to 13.3º C. Stream temperatures collected May through September 1998 averaged 10.3º C. Temperatures exceeded rearing requirements for bull trout, although those high temperatures (21º C in July) were single day events.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Data Gap
The existing riparian reserve network in the Miller River subwatershed provides adequate shade, recruitment of large woody debris, and habitat protection and connectivity (USFS, 2000) largely because about 79% of the watershed is in the Alpine Lakes Wilderness Area. LWD was removed from the lower river in the 1970s for flood control and current wood loading is thought to be low (USFS, 2000). However, LWD frequency has not been quantified.

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Intact
The lack of development or management in the floodplain or riparian areas along the mainstem has allowed the mainstem channels to stay connected with its floodplain (USFS, 2000).

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	X
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	
2.3	Actively eroding banks	X	5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap		5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area			Data gap	X
3.2	Annual hydrograph characteristics	X	6. Shoreline Condition and Floodplain Connectivity		
	Data gap		6.1	Shoreline hardening and overwater structures	X
				Data gap	

Olney Creek (headwaters – May/Lower Wallace RM 4.8)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Data Gap
There is a natural barrier to anadromous fish at RM 0.95.

Habitat Condition 2. Sediment
Data Gap

Habitat Condition 3. Hydrology
Data Gap

Habitat Condition 4. Water Quality
Data Gap

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Data Gap

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Data Gap

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage		4.1	Water quality standards	
	Data Gap	X	4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	X
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area			Data gap	X
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap	X	6.1	Shoreline hardening and overwater structures	
				Data gap	X

Rapid River (headwaters – Beckler RM 7.9)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Intact
No human-made barriers to anadromous fish passage are known to exist. Historically, no anadromous species existed in the Rapid River subwatershed because Sunset Falls is a natural migration barrier on the South Fork Skykomish River.

Habitat Condition 2. Sediment
Degraded
Unstable streambanks are evident over approximately 31% of channel length due to mass wasting, debris jams, and bank erosion (USFS, 1999).

Habitat Condition 3. Hydrology
Data Gap
There is some evidence of altered peak flow characteristics resulting from past timber harvesting and road building in the rain-on-snow zone (USFS, 1995a; USFS, 1999). However, there are neither active nor past discharge gages in the Rapid River subwatershed.

Habitat Condition 4. Water Quality
Intact
Between 1994 and 1999, monthly water temperature monitoring in the Rapid River indicated exceedance of the threshold of 13.9º C on one occasion (Tulalip Tribes, unpublished data). Measurements in the mainstem Rapid River in 1980 indicated temperatures as high as 15º C (USFS, 1995a).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Data Gap
The Forest Service rated the Rapid River subwatershed as "degraded" due to low frequency of LWD in the lower Rapid River compared to undisturbed regions (USFS, 1995a). The upper Rapid River is in Wilderness designation and presumed to be "intact".

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Data Gap
The extent of bank armoring has not been quantified.

The performance criteria checked below are applied in the assessment of this subwatershed						
1. In-stream Artificial Barriers to Habitat				4. Water Quality		
1.1	Fish Passage	X		4.1	Water quality standards	
	Data Gap			4.2	Sediment quality	
2. Sediment				4.3	Salmonid temperature requirement	X
2.1	Embeddedness			4.4	Bull trout temperature requirement	
2.2	Fine sediment				Data gap	
2.3	Actively eroding banks	X		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs			5.1	Shoreline buffer	
2.5	Sediment transport			5.2	Wetland, estuarine, and nearshore reserves	
	Data gap			5.3	Large woody debris	
3. Hydrology				5.4	Average stem diameter	
3.1	Total impervious area				Data gap	X
3.2	Annual hydrograph characteristics			6. Shoreline Condition and Floodplain Connectivity		
	Data gap	X		6.1	Shoreline hardening and overwater structures	
					Data gap	X

Skykomish River – Lower Mainstem (RM 15.2 – Mainstem Snohomish RM 19.6)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
The WDFW culvert database indicates the presence of 41 known culverts that are fish passage barriers in fish bearing streams. There are 32 culverts in the lower Skykomish that are of unknown barrier status (WDFW, 2002)[30]. For this report, the database was not reviewed for fishways and dams. Many of the culverts are on unnamed tributaries to the lower Skykomish River, some are in the Elwell Creek drainage, and multiple culverts are found on Ben Howard Road. Eleven culverts are located on Wagleys Creek in the city of Sultan.

Habitat Condition 2. Sediment
Data Gap
Sediment loads from the reaches of the Skykomish River are deposited in the lower Skykomish River near Monroe and at the Skykomish-Snoqualmie River confluence. Bedload sediment sources on the Skykomish River are the North and South Forks, along with various local contributions of sediment from banks and smaller tributaries. The rate of bedload deposition in the Skykomish River between Monroe and the confluence ranges from 6,000 to 21,000 cubic yards/year. Exceedance of this deposition rate by gravel mining would cause the gravel beds in the Skykomish River to degrade. The total sediment load for the Skykomish River at Monroe is estimated at 358,000 tons/year, the bedload is 36,000 tons/year and suspended load is 322,000 tons/year (Dunne, 1979). Between Gold Bar and Monroe, the Skykomish receives small inputs of gravel and relatively larger inputs of suspended sediment. There are no known fine sediment studies on the mainstem Skykomish River.

Habitat Condition 3. Hydrology
Moderately Degraded
Total impervious surface is estimated to be eight percent (Purser and Simmonds, 2002).

Habitat Condition 4. Water Quality
Degraded
This subwatershed is on the 1998 303(d) list for copper, lead, silver, stream temperature, and fecal coliform bacteria. Copper, lead, and silver listings result from measurements taken near Monroe, T27N R06E S12. Temperature violations were also documented downstream of Proctor Creek. Fecal coliform violations were documented in two locations, upstream of Monroe T27N R07E S6 and downstream of Proctor Creek T27N S09E S9. The City of Monroe discharges wastewater effluent into the Skykomish River.

[30] In the WDFW culvert database, unknown status means that the culvert is beyond Level B analysis or Level B analysis is required but has not been conducted.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Approximately 60% of the riparian corridor between Gold Bar and Monroe is greater than 200 feet wide (Pentec and NW GIS, 1999). The riparian zone in Haskell Slough has 0.57 miles of dense, young vegetation and 0.30 miles of bare earth (Michalak, in prep.).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Moderately Degraded
Approximately 18% of the mainstem shoreline is hardened between Gold Bar and Monroe (Pentec and NW GIS, 1999). Haskell Slough is hardened at the upstream end, reducing flow volume and fish access.

The performance criteria checked below are applied in the assessment of this subwatershed		
1. In-stream Artificial Barriers to Habitat		
1.1	Fish Passage	X
	Data Gap	
2. Sediment		
2.1	Embeddedness	
2.2	Fine sediment	
2.3	Actively eroding banks	
2.4	Feeder bluffs	
2.5	Sediment transport	
	Data gap	X
3. Hydrology		
3.1	Total impervious area	X
3.2	Annual hydrograph characteristics	
	Data gap	
4. Water Quality		
4.1	Water quality standards	X
4.2	Sediment quality	
4.3	Salmonid temperature requirement	X
4.4	Bull trout temperature requirement	
	Data gap	
5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
5.1	Shoreline buffer	X
5.2	Wetland, estuarine, and nearshore reserves	
5.3	Large woody debris	
5.4	Average stem diameter	
	Data gap	
6. Shoreline Condition and Floodplain Connectivity		
6.1	Shoreline hardening and overwater structures	X
	Data gap	

Skykomish River – Upper Mainstem (headwaters – Mainstem Skykomish RM 15.2)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
The WDFW culvert database indicates the presence 18 known fish passage barriers in the upper mainstem Skykomish River. There are 14 culverts of unknown fish passage in the upper mainstem Skykomish River (WDFW, 2002). The barriers are associated with the BNSF Railroad and private driveways. Eight culverts are located on road number 22720 and four culverts are located on road number 22740.

Habitat Condition 2. Sediment
Data Gap
The river receives bedload from the forks and picks up additional bedload from the glacial outwash deposits between Index and Gold Bar. Dunne estimates the total sediment load for the upper mainstem (breaking at Gold Bar) to be 340,000 tons/year, bedload is 34,000 tons/year and suspended load is 306,000 tons/year (Dunne, 1979).

Habitat Condition 3. Hydrology
Intact
Total impervious surface area is estimated to be five percent (Purser and Simmonds, 2002).

Habitat Condition 4. Water Quality
Moderately Degraded
The upper mainstem is on the 1998 303(d) list for temperature at RM 43.7.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Constraints on the riparian buffer are created by infrastructure (primarily the BNSF Railroad), agricultural practices, and the city of Gold Bar. Thirty-five percent of the riparian zone is less than one SPT wide (Michalak, 2001).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Degraded
Approximately 40% of the mainstem shoreline (11.64 river miles) is encroached by BNSF Railroad, private roads, and public road bridges (Savery, in prep.).

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	X
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	X
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area	X		Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap		6.1	Shoreline hardening and overwater structures	X
				Data gap	

Skykomish River – Lower North Fork (RM 9.9 – Mainstem Skykomish RM 28.9)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Moderately Degraded
There are eight blocking culverts and one culvert of unknown blockage status in the WDFW culvert database. There are five blocking culverts owned by Snohomish County that have been rated as requiring repair due to the amount of fish habitat that would become available (WDFW, 2002). These culverts are on unnamed tributaries on the North Fork Skykomish River. There are two privately owned culverts and one city owned culvert that block access to unnamed tributaries in this subwatershed.

Habitat Condition 2. Sediment
Data Gap
Dunne estimates total sediment load for the North Fork Skykomish at Index as 30,000 tons/year, bedload is 3,000 tons/year, and suspended load is 27,000 tons/year (Dunne, 1979). The USFS measured suspended sediment in the North Fork ranging from 1 - 162 mg/L in 1967-8 (David Evans and Associates, 1999).

Based on known channel widening over a 30-year period in the lower watershed since 1962, (162 feet wide in 1962 and 201 feet wide in 1991) (USFS, 1997), known areas of unstable soils, and very limited quantitative data and on rates of sediment delivery to channels from surface erosion, bank avulsions, and mass failures, substrate embeddedness is "functioning at risk"[31] (David Evans and Associates, 1999). Sediment in spawning and incubation areas is also "functioning at risk" (David Evans and Associates, 1999).

Streambank conditions appear to be generally stable and good, although there are notable exceptions along the mainstem North Fork Skykomish River and some tributaries (e.g., Silver Creek and downstream of it in the mainstem North Fork Skykomish River). Overall, streambanks are "functioning appropriately" (David Evans and Associates, 1999).

Habitat Condition 3. Hydrology
Data Gap

Habitat Condition 4. Water Quality
Data Gap
No waterbodies are on the 303(d) list. Temperatures measured in late September and October at several locations (including Silver Creek and the mainstem North Fork Skykomish River) ranged from 9.4 - 16.7º C (David Evans and Associates, 1999; USFS, 1997). The Tulalip Tribes measured a peak turbidity of 15 NTUs in 1995 (Nelson, 1995). In 2001- 2002, Salmon Creek and Trout Creek had a seven-day moving average for bull trout spawning and incubation of less than 6º C (Tulalip Tribes, unpublished data).

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[31] The terms "functioning at risk" and "functioning appropriately" are used by David Evans and Associates, 1999. In this report, the terms are included for the discussion of the lower North Fork, upper North Fork, and South Fork of the Skykomish River.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Stand dynamics have been disrupted by historical and current logging (USFS, 1997). Vegetative structure in the North Fork Skykomish River is composed of four percent early seral, 18% mid seral, 53% late seral (USFS, 1997). The percentages do not add up to 100 as areas outside of the National Forest are not analyzed.

Instream habitat surveys from Index to RM 10.4 found 26.6 pieces of wood/mile or 0.33 pieces of wood/channel width (greater than 20m). These counts excluded wood in logjams and side channels (David Evans and Associates, 1998).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Degraded
Side channel habitat and floodplain connectivity is limited on the left bank of the North Fork due to County Road and residential encroachment within the floodplain. Approximately 36% of shoreline (7.26 river miles) is affected by private and public road encroachment (Savery, in prep.).

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	X
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	X
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area			Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap	X	6.1	Shoreline hardening and overwater structures	X
				Data gap	

Skykomish River – Upper North Fork (headwaters – lower N. F. Skykomish RM 9.9)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Intact
There are few human-made barriers—none of which occur within the mainstem of the North Fork Skykomish River (USFS, 1997).

Habitat Condition 2. Sediment
Moderately Degraded
Snohomish County Surface Water Management assessed fine sediments (less than 6.3mm) in 8.15 km, of the upper North Fork Skykomish subwatershed using reaches based on Rosgen channel typing. They found mean surface fine sediment levels to range from 1 to 27%. Percent mean streambank instability ranged from 0 to 4.9% (Snohomish County SWM, 2002).

Dunne estimates total sediment load for the North Fork Skykomish River at Index as 30,000 tons/year, bedload is 3,000 tons/year and suspended load is 27,000 tons/year (Dunne, 1979). The USFS measured suspended sediment in the North Fork ranging from 1 - 162 mg/L in 1967-1968 (David Evans and Associates, 1999).

Streambank conditions appear to be generally stable and good, although there are notable exceptions along the mainstem North Fork Skykomish River and some tributaries (e.g., Silver Creek and downstream of it in the mainstem North Fork Skykomish River). Overall, streambanks are “functioning appropriately” (David Evans and Associates, 1999).

Based on known channel widening over a 30-year period in the lower watershed since 1962 (150 feet wide in 1962 and 200 feet wide in 1991) (USFS, 1997), known areas of unstable soils, and very limited quantitative data and on rates of sediment delivery to channels from surface erosion, bank avulsions, and mass failures, substrate embeddedness is “functioning at risk” (David Evans and Associates, 1999). Sediment in spawning and incubation areas is also “functioning at risk” (David Evans and Associates, 1999).

Habitat Condition 3. Hydrology
Data Gap
Past timber harvest practices in the watershed have altered hydrologic processes by increasing the amount of open area available for snow accumulation (David Evans and Associates, 1999). 18.8% of the North Fork is in the rain-on-snow zone (WDFW, 1999).

Habitat Condition 4. Water Quality
Data Gap
No waterbodies are on the 303(d) list. Temperatures measured in late September and October at several locations (including Silver Creek and the mainstem North Fork Skykomish River) ranged from 9.4 - 16.7º C (David Evans and Associates, 1999; USFS, 1997). Troublesome Creek had a seven-day moving average for bull trout spawning and incubation of less than 6º C, except for one week in November, 2001. West Cady Creek had a seven-day moving average

well below 6º C during the bull trout spawning and incubation period (Tulalip Tribes, unpublished data). Both streams are “intact” for bull trout spawning and rearing.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Moderately Degraded
In 2001, Snohomish County SWM assessed LWD frequency in 8.15 km of the upper North Fork Skykomish subwatershed using reaches based on Rosgen channel typing. In 0.45 km of channel width less than 10m, mean LWD frequency was 0.47 pieces/channel width. In 1.89 km of channel width between 10 - 20m, mean LWD frequency was 0.58 pieces/channel width (“intact”). In 5.81 km of channel width greater than 20m, mean LWD frequency ranged from 0.91 to 2.41, which falls in the range of “intact” to “degraded” (Snohomish County SWM, 2002).

Surveys in 1991-2 found overall LWD occurrence to be 211 pieces/mile or approximately two pieces/channel width (channel width 10 - 20m) (David Evans and Associates, 1999).

Riparian vegetation surveyed from RM 10.8 to RM 20.8 was primarily composed of both western hemlock and red alder in the small tree seral class (9 - 20.9 inches dbh; 22.9 - 53.1cm dbh) (USFS, 1997). Trees greater than 24-inch dbh and 50 feet long comprised seven percent of the riparian vegetation (USFS, 1997).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Moderately Degraded
Approximately 12% of the mainstem shoreline (4.86 river miles) is affected by private and public road encroachment (Savery, in prep.). Side channel habitat and floodplain connectivity is limited on the left bank of the North Fork due to county road and residential encroachment within the floodplain. West of Galena, the road crosses to the right bank of the river and further encroaches the floodplain.

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			**4. Water Quality**		
1.1	Fish Passage	X	4.1	Water quality standards	
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment	X		Data gap	X
2.3	Actively eroding banks	X	**5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD**		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap		5.3	Large woody debris	X
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area			Data gap	
3.2	Annual hydrograph characteristics		**6. Shoreline Condition and Floodplain Connectivity**		
	Data gap	X	6.1	Shoreline hardening and overwater structures	X
				Data gap	

Skykomish River – Lower South Fork (RM 6.6 – Mainstem Skykomish RM 28.9)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Moderately Degraded
Artificial barriers are limited to upper reaches of tributary streams (WDFW, 1999). Access to tributaries is important for resident trout (Kraemer, 2002). Historically, no anadromous species existed in the lower South Fork subwatershed because Sunset Falls is a natural migration barrier on the South Fork Skykomish River. Since 1958, migration has been possible due to a trap and haul facility at Sunset Falls.

Habitat Condition 2. Sediment
Data Gap
Dunne estimates total sediment load for the South Fork Skykomish at Index as 200,000 tons/year, bedload is 20,000 tons/year, and suspended load is 180,000 tons/year (Dunne, 1979).

USFS measured suspended solids ranging from 1 - 251 mg/L in 1967-8 (David Evans and Associates, 1999). Road density in the Sorth Fork is 1.71 miles/square mile. Forty-six percent of the overall Sorth Fork Skykomish River subwatershed is in the high hazard category for human-induced mass wasting potential (USFS, 1997).

Habitat Condition 3. Hydrology
Data Gap

Habitat Condition 4. Water Quality
Intact
There are no 303(d) listings. While water quality generally meets state standards, there are local problems with acid mine runoff, current and historic discharges from a petroleum contaminated site, septic failures, and metal contamination. Use of the fuel pit in Skykomish River by the BNSF Railroad was discontinued in 1973. There is ongoing work to address contaminated sediments in this area. The Snohomish County Health Department has worked to address septic failures in the area (WDFW, 1999).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Data Gap

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Degraded
Public and private roads and BNSF Railroad encroachment affect 46.5% (7.07 river miles) of the shoreline (Savery, in prep.). The north bank of the Sorth Fork Skykomish River has been armored and is constrained by the BNSF Railroad. Additionally the Bonneville Power Administration utility corridor restricts the channel on the north bank. The south bank of the river is constrained by a county road that extends to Eagle Falls, cutting the river off from the majority of its floodplain.

The performance criteria checked below are applied in the assessment of this subwatershed						
1. In-stream Artificial Barriers to Habitat				4. Water Quality		
1.1	Fish Passage	X		4.1	Water quality standards	X
	Data Gap			4.2	Sediment quality	
2. Sediment				4.3	Salmonid temperature requirement	
2.1	Embeddedness			4.4	Bull trout temperature requirement	
2.2	Fine sediment				Data gap	
2.3	Actively eroding banks			5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs			5.1	Shoreline buffer	
2.5	Sediment transport			5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X		5.3	Large woody debris	
3. Hydrology				5.4	Average stem diameter	
3.1	Total impervious area				Data gap	X
3.2	Annual hydrograph characteristics			6. Shoreline Condition and Floodplain Connectivity		
	Data gap	X		6.1	Shoreline hardening and overwater structures	X
					Data gap	

Skykomish River – South Fork (RM 14.1 – lower S. Fork Skykomish RM 6.6)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Moderately Degraded
There are a few constructed barriers, none of which occur in the mainstem of the Sorth Fork Skykomish River. The known artificial barriers (mostly partially or completely impassable culverts) occur on some tributaries (USFS, 1997; David Evans and Associates, 1999).

Habitat Condition 2. Sediment
Data Gap
Dunne estimates total sediment load for the South Fork Skykomish at Index as 200,000 tons/year, bedload is 20,000 tons/year, and suspended load is 180,000 tons/year (Dunne, 1979). Road density in the Sorth Fork is 1.71 miles/square mile. Forty-six percent of the overall South Fork Skykomish subwatershed is in the high hazard category for human-induced mass wasting potential (USFS, 1997).

Habitat Condition 3. Hydrology
Intact
Total impervious area is estimated to be six percent (Purser and Simmonds, 2002).

Habitat Condition 4. Water Quality
Moderately Degraded
Although there are no 303(d) listings in this subwatershed, information available indicates that water quality is "moderately degraded". Chronic sources of toxic chemicals exist in the soil, groundwater, and some surface waters near the City of Skykomish near the BNSF Railroad oil storage facilities. The stockpiles of ore concentrates and flue dusts at active and abandoned mines near Money Creek contribute metals to the river (USFS, 1997).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Moderately Degraded
Vegetative structure in the subwatershed is comprised of five percent early seral, 41% mid seral, 30% late seral (USFS, 1997). Percentages do not add up to 100% because non-Forest Service land is not analyzed. Mid seral is considered to be 30 - 50cm dbh, late seral is considered to be greater than 50cm dbh.

LWD recruitment needs are not fully being met by hardwood stands along the South Fork Skykomish River (USFS, 1997).

Habitat Condition 6. Shoreline Connection and Floodplain Connectivity
Degraded
Approximately 41.8% of the shoreline (11.8 river miles) is affected by encroachment from public and private roads and BNSF Railroad (Savery, in prep.). Development associated with Baring has armored the riverbanks. Generally, the South Fork Skykomish is isolated from its floodplain.

Aerial photography and qualitative observations from stream walks indicate that side-channel habitat is limited in the mainstem South Fork Skykomish River and some of its tributaries (USFS, 1997).

Wetted width/maximum depth ratios in the Skykomish River watershed above the forks tended to range from 11 - 20, which is too high for the designated Rosgen channel type, resulting in an overall assessment of “functioning at risk” (David Evans and Associates, 1999).

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area	X		Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap		6.1	Shoreline hardening and overwater structures	X
				Data gap	

Skykomish River - Upper South Fork (RM 19.8 – South Fork Skykomish RM 14.1)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Moderately Degraded
There are a few human-made barriers, none of which occur in the mainstem of the South Fork Skykomish River. The known artificial barriers (mostly partially or completely impassable culverts) occur on some tributaries (USFS, 1997; David Evans and Associates, 1999).

Habitat Condition 2. Sediment
Data Gap
Dunne estimates total sediment load for the South Fork Skykomish at Index as 200,000 tons/year, bedload is 20,000 tons/year, and suspended load is 180,000 tons/year (Dunne, 1979). Road density in the Sorth Fork is 1.71 miles/square mile. Forty-six percent of the overall South Fork Skykomish subwatershed is in the high hazard category for human-induced mass wasting potential (USFS, 1997).

Maloney Creek has deep alluvial deposits aggraded near its mouth following flood events in late 1995 and early 1996, which has greatly diminished channel capacity and ability to pass flood waters (USFS, 1997).

Habitat Condition 3. Hydrology
Data Gap
The hydrologic cumulative effects analysis in the Mount Baker Snoqualmie Forest Plan states that areas with greater than 12% vegetative disturbance are of concern. The upper Sorth Fork Skykomish River has 16% vegetative disturbance.

Habitat Condition 4. Water Quality
Moderately Degraded
Although there are no 303(d) listings in the subwatershed, information available indicates that water quality is “moderately degraded”. Water pollution sources and miscellaneous observations of elevated fecal coliform counts have been reported downstream of the City of Skykomish (USFS, 1997; Gall, 2000). Chronic sources of toxic chemicals exist in the soil, groundwater, and some surface waters near the City of Skykomish near the BNSF Railroad oil storage facilities.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Moderately Degraded
Vegetative structure in the subwatershed is comprised of five percent early seral, 41% mid seral, 30% late seral (USFS, 1997). Percentages do not add up to 100% because non Forest Service land is not analyzed. Mid seral is considered to be 30 - 50cm dbh and late seral is considered to be greater than 50cm dbh.

LWD recruitment needs are not fully being met by hardwood stands along the Sorth Fork Skykomish River (USFS, 1997).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Degraded
The upper Sorth Fork Skykomish River flows through a confined valley that averages 0.5 miles in width (USFS, 1997). Although naturally confined, the river is further constrained by travel corridors. Approximately 39% of the shoreline (4.08 river miles) is affected by encroachment of public and private roads and BNSF Railroad (Savery, in prep). The north bank of the Sorth Fork Skykomish River has been armored and is constrained by Highway 2 in two places on the north bank and one crossing. The south bank has been armored and is constrained by the BNSF Railroad and part of the USFS road network. Revetments, bridges, and development associated with the City of Skykomish have especially impacted the left bank (south side) of the Sorth Fork Skykomish River throughout its length (David Evans and Associates, 1999).

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Surface fines			Data gap	
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area			Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap	X	6.1	Shoreline hardening and overwater structures	X
				Data gap	

Sultan River – Lower[32] (RM 16.4 – Mainstem Skykomish RM 13.9)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
The City of Everett's diversion dam for municipal water supply located at RM 9.7 blocks fish passage to at least 6.8 miles of river since early in the last century. There are road culverts with unknown fish passage status in the WDFW Fish Passage Culvert Database (WDFW, 2002).

Habitat Condition 2. Sediment
Degraded
A dam and reservoir intercept previous contributions from upstream. Previous and ongoing monitoring document that gravel quantity and quality are being maintained. Results from four sampling years (1982, 1984, 1987, and 1994) show that the percentage of fine sediment is below the 12% threshold for criterion 2.2 (Miller et al., 1984). The sampling period covers pre- and post-construction of Stage II of the Jackson Project in the Sultan River subwatershed. Samples were obtained by tri-tube freeze cores at five locations in four channel bed strata.

Gravel sampling sites are in productive spawning areas of the river. Those areas are also monitored for scour depth of river channel gravel. Although the frequency and peaks of high flows have been reduced, effective scouring and scour depth still occur. The mean average depth of scour ranges from less than one inch to over 10 inches.

Gravel supply recruitment areas exist downstream from Culmback Dam. Sediment transport occurs when the flow reaches 2,500 cfs. The lower river was historically gravel supply limited because of natural deposition in a braided channel area above Culmback Dam. However, sufficient supply sources exist downstream (Miller et al., 1984).

The amount of sedimentary material produced and transported from the principal source of supply, Blue Mountain area, is estimated to be 3,000 cubic yards/year (Miller et al., 1984). Streambed slope analysis indicates that material will be transported downstream, be deposited in existing spawning areas, and may result in a net increase of usable spawning habitat (Schuh and Meaker, 1995). This outcome is due to the reduced frequency of high flow events. The assessment is based on criteria that watershed processes have been changed from natural conditions. Seventeen years of monitoring indicates successful mitigation, thus far, with gravel.

[32] The application of performance criteria to present habitat conditions in the regulated Sultan River will produce some assessments contrary to the recent historical record of fish production (Schuh and Metzgar, 1994). Analyses by fish biologists of habitat conditions and changes due to construction and operation of the Jackson Project were done in the late 1970s and early 1980s under both SEPA and NEPA regulations. Net benefit to fishery production (Eicher, 1981a & b and FERC, 1981a) was projected, and appears to be substantiated by years of spawner surveys (Snohomish County PUD and Everett, in prep.). Implementation of the required, approved, and amended fish mitigation plan for the Jackson Project has been acceptable to the resource agencies and the Tulalip Tribes as of this writing, based upon their response to a series of annual reports prepared by the Snohomish County PUD. A biological assessment under Section 7 of the Endangered Species Act is in progress. Adaptive management has been continuous prior to and will continue due to the ESA listings for chinook salmon and bull trout (Snohomish County PUD and Everett, in prep.).

Habitat Condition 3. Hydrology
Degraded
There are pronounced changes in the hydrograph due to regulation of high flows and augmentation to low flows by Jackson Project operation. Historically, habitat in the reach between the dams and in the lower river was limited by frequent occurrence of high flows (Eicher 1981a & b). Reduction of the frequency, duration, and velocity of peak flows has decreased the damage to redds, alevins, and juvenile rearing (Eicher, 1981a & b). Under natural conditions (pre-1965), flows between 2,000 and 5,000 cfs occurred every year on the average of 22 days/year at the diversion dam. Those between 5,000 and 10,000 cfs occurred an average of 2.8 days/year, and for over 10,000 cfs one day in 2.4 years (Eicher, 1981b). Peak flows still occur, but about once every six years. (USGS, various.) If greater frequency is needed with high flows sufficient to maintain habitat conditions, they can and will be allowed to occur (Schuh and Meaker, 1995).

Naturally occurring low flows were in the range of 50 - 60 cfs (USGS, various). A minimum instream flow schedule determined by fishery resource agencies for habitat protection and enhancement has been established by Federal license (FERC, 1981b, 1982, 1983) and state water rights permit. The instream flow schedule ranges from 95 cfs up to 175 cfs at the diversion dam (RM 9.7) and a minimum flow range of 165 to 200 cfs downstream from the powerhouse (RM 4.5) (FERC 1981a, 1982, 1983). Those requirements are being fulfilled and verified with continuous monitoring and reporting (USGS, various).

Total impervious area is estimated to be 2.5% (Purser and Simmonds, 2002).

Habitat Condition 4. Water Quality
Intact
There are no 303(d) listings. Flow releases from the reservoir are regulated to match historical seasonal water temperature patterns, although some warming has occurred during winter due to reservoir stored waters.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Intact
Downstream from Culmback Dam over 14 miles (85%) are “intact” because they have a mature conifer buffer at least 60 years old and a minimum of 150 feet wide. From RM 16.5 to RM 9.7 mostly old growth forest lines the banks of the river. From the City of Everett’s diversion dam (RM 9.7) to the Bonneville Power Administration power lines crossing (RM 3.3), the riparian forest is at least 60 years old and averages about 50cm in diameter. From the powerlines to the confluence with the Skykomish River, the estimate is about 80% cover with an age of 30 to 60 years. The next 1.25 miles is a well-stocked mix of conifer and hardwood about 40 years old. It is “intact”, but a young stand. The reach (1.25 miles) nearest the confluence is “moderately degraded” because there is no buffer outside of the channel migration zone, although the channel migration zone probably has always looked like it does now (Farwell, 2001). Overall, the habitat is “intact” because only the lower 2.5 miles are “moderately degraded”.

LWD has not been inventoried. Its probable historic source area was primarily the channel migration zones in the upper subwatershed. In 1965, this area was disconnected by Culmback Dam.

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Intact
Limited floodplain and side channels exist due to local geology. Most of the river channel is deeply incised in bedrock from RM 16.5 to RM 3.3. Some off-channel habitat in the lower three miles is disconnected from the river from time-to-time due to reduced frequency and duration of high flows, although frequent high flows have been assessed as limiting fish production (Eicher 1981a & b). Near the mouth, shoreline has been mildly affected by residential development and bank hardening. There is also limited bank armoring (about 100 feet) and a dam wing-wall at the diversion dam (RM 9.7). Since less than 10% of the entire shoreline has been hardened and there are no over water structures, except for the Highway 2 bridge at the confluence, the habitat is "intact".

The performance criteria checked below are applied in the assessment of this subwatershed

1. In-stream Artificial Barriers to Habitat		
1.1	Fish Passage	X
	Data Gap	
2. Sediment		
2.1	Embeddedness	
2.2	Fine sediment	X
2.3	Actively eroding banks	
2.4	Feeder bluffs	
2.5	Sediment transport	X
	Data gap	
3. Hydrology		
3.1	Total impervious area	
3.2	Annual hydrograph characteristics	X
	Data gap	

4. Water Quality		
4.1	Water quality standards	X
4.2	Sediment quality	
4.3	Salmonid temperature requirement	
4.4	Bull trout temperature requirement	
	Data gap	
5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
5.1	Shoreline buffer	X
5.2	Wetland, estuarine, and nearshore reserves	
5.3	Large woody debris	
5.4	Average stem diameter	X
	Data gap	
6. Shoreline Condition and Floodplain Connectivity		
6.1	Shoreline hardening and overwater structures	X
	Data gap	

Sultan River – Upper (headwaters – lower Sultan RM 16.4)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Data Gap (Upstream) and Degraded (Downstream)
Culmback Dam blocks access at RM 16.5, although it is not known whether anadromous fish could pass upstream of the site historically. Information available on pre-dam conditions is inadequate to determine suitability for fish passage, although downstream passage is assumed. The reservoir (Spada Lake) changes the water surface elevations due to tributary inflows and withdrawals by the Jackson Project (FERC, 1983). While these water level changes periodically either inundate or expose the lower portions of tributary channel, “both species (rainbow and cutthroat trout) have free access to headwater areas of” the major tributaries. Both adfluvial and resident populations are present (Pfeifer et al., 1998).

Habitat Condition 2. Sediment
Data Gap
Logging activity ceased several years ago on public lands. Any future timber sales will be very limited on public lands and many miles of logging roads have been decommissioned. Future logging on state land will be guided by the Final Habitat Conservation Plan (WDNR, 1997) and evolving regulatory regimes. Over 20,000 acres of state land have been transferred from trust to Natural Resource Conservation Area status (WDNR, 1992). The Forest Service has proposed limited timber harvest (100 - 300 acres/decade) on national forest lands in the subwatershed through the next 20 years.

Habitat Condition 3. Hydrology
Intact
Total impervious area is estimated to be four percent (Purser and Simmonds, 2002). Open water (Spada Lake) is not included in the estimate.

Stream flow gaging stations were operated from 1976 to about 1983 on Elk (Sta #1372) and Williamson (Sta #1372.60) creeks. The drainage areas above these gages are 11.4 and 15.6 square miles, respectively, and account for 38% of the drainage area above Culmback Dam. The extremes for the period of record for Elk Creek are 4,080 cfs and 7.9 cfs while Williamson Creek had 5,540 cfs and 12 cfs (due to freeze-up) (USGS 1985).

Road access no longer exists for the entire northern and northeastern areas in this subwatershed. Logging in the subwatershed last occurred about 1991. Additionally, extensive acreage (over 20,000 acres) has been dedicated to Natural Resource Conservation Areas (WDNR, 1992). No effort was made to correlate possible effects of past logging on stream hydrographs because of the length of time since the gaging stations ceased operation and when landscape changes occurred.

Habitat Condition 4. Water Quality
Intact
No segments are on the 303(d) list. The National Forest land use management plan intends to protect municipal water supply watersheds (USFS, 1990). The City of Everett and Washington Department of Natural Resources have an agreement to protect water quality in the watershed.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Data Gap
Data on forest cover adjacent to streams indicates 85% cover. However, about one-half of this is less than 30 years old. Because of dominance of young forest cover, the average stem diameter is assumed to be 30 - 50cm dbh (Purser and Simmonds, 2002) although field data is lacking.

For the littoral zone of the reservoir, no assessment is made because the habitat conditions and performance criteria do not match.

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Data Gap

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap	X	4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area	X		Data gap	X
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap		6.1	Shoreline hardening and overwater structures	
				Data gap	X

Tye River (headwaters – upper S. Fork Skykomish RM 19.8)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Intact
The upstream end of anadromous migration ends at Alpine Falls, about 4.6 miles above the mouth of the Tye River. Migration is possible up to Alpine Falls because of a trap and haul facility at Sunset Falls, about 22 miles downstream. No human-made barriers to anadromous passage are known to exist (USFS 1998a).

Habitat Condition 2. Sediment
Data Gap
The Forest Service has documented bank slumping and other chronic sediment inputs into the Alpine Creek and middle Tye River (USFS 1998a). There are also some large bank failures in the lower reaches of the Tye River and excessive bar formation in the mainstem of the Tye River below Alpine Falls (USFS 1998a). Sanding of Highway 2 is a chronic contributor of fine sediment, but the extent of the impact is unknown (USFS 1998a). Observations of streambank conditions at spawning grounds between 1994-99 recorded chronic sediment input to the river (Tulalip Tribes, unpublished data).

Habitat Condition 3. Hydrology
Data Gap
Discharge data is lacking for the Tye River subwatershed. As one-third of the Tye River subwatershed is in the rain-on-snow zone, rain-on-snow events are thought to be the dominant process generating peak flows and floods. Given the low level of vegetative disturbance in this zone (15%), the Forest Service characterizes the subwatershed as "hydrologically mature" (USFS 1998a).

Habitat Condition 4. Water Quality
Moderately Degraded
There are no 303(d) listed segments in the Tye River subwatershed. However, the Tulalip Tribes have sampled temperature on a monthly basis between 1994 and 1999. Temperatures exceeded 14º C during sampling in August 1997 and 1998 (Tulalip Tribes, unpublished data).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Data Gap
LWD levels are low in the mainstem below Alpine Falls (16 - 20 pieces/mile in 1989) and more abundant above the falls and in the tributaries (USFS, 1998a). Development and maintenance associated with the ski area, as well as timber harvest, powerline corridor maintenance, and highway construction have fragmented riparian buffers (USFS 1998a). The extent of the impact has not been quantified.

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Data Gap
The Stevens Pass Highway, other roads, powerline right of ways, BNSF Railroad, and townsites along the Tye River have constricted the floodplain. Old meander flats have been cut-off by highway and road fills. It appears that there has been some loss of historic floodplain capacity as a result (USFS, 1998a). The extent of the modified banks has not been quantified.

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	X
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area			Data gap	X
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap	X	6.1	Shoreline hardening and overwater structures	
				Data gap	X

Wallace River – Upper (headwaters – May/lower Wallace RM 4.8)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
The hatchery weir restricts adult passage into the subwatershed from November through May (Hatfield, 1999). Wallace Falls is a natural barrier to anadromous fish.

Habitat Condition 2. Sediment
Data Gap
Dunne estimates the total sediment load for the Wallace River at Gold Bar to be 2,000 tons/year, bedload is 200 tons/year, and suspended load is 1,800 tons/year (Dunne, 1979).

Habitat Condition 3. Hydrology
Intact
Total impervious area is estimated to be one percent (Purser and Simmonds, 2002).

Habitat Condition 4. Water Quality
Data Gap

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Moderately Degraded
Twenty-nine percent of riparian reserve on National Forest is in non-forested conditions (USFS, 1997).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Data Gap
Data are limited on bank armoring. Approximately 0.5 mile of shoreline is hardened between RM 6 - 6.5 (WDFW, 1998).

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	X
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	X
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area	X		Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap		6.1	Shoreline hardening and overwater structures	
				Data gap	X

Woods Creek (headwaters – lower Woods RM 3.7)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
Eight of the nine culverts inventoried in the Fish Passage Culvert Inventory are identified as barriers or unknown status (WDFW, 2002). Data from a 1996 culvert survey by Washington Trout show eight tributaries on the main east fork may have blockage at low flows (Washington Trout, 2001).

Habitat Condition 2. Sediment
Degraded
Pebble count data from the Tulalip Tribes (Tulalip Tribes, unpublished data) show fine sediment levels in Timber Creek and Lake Roesiger Creek (above natural migration barrier) at 51.74% and 19.73%, respectively (grain size less than 2mm). A 1984 physical stream survey by the Tulalip Tribes documents the presence of high percentages of sand and silt throughout the subwatershed in spawning gravel (Thorn et al., 1992). Cobble embeddedness is greater than 35%, throughout the entire Woods Creek subwatersheds (Woods Creek, Woods Creek-lower, and Woods Creek-West Fork), exceptions being in higher gradient reaches where scour occurs (Thorn et al., 1992).

Habitat Condition 3. Hydrology
Intact
The total impervious area of Woods Creek is estimated to be three percent (Purser and Simmonds, 2002).

Habitat Condition 4. Water Quality
Data Gap
A Metal Tolerance Index (MTI) of 2.37 indicates that Lake Roesiger Creek may have significant loading of metals (Tulalip Tribes, unpublished data). In *The State of the Waters: Water Quality in Snohomish County's Rivers, Streams and Lakes.* Woods Creek problems are listed as fecal coliform bacteria and sediment (Thornburgh, 1996).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Data Gap
Woods Creek has 56% mixed forest, 3% mature evergreen forest, and 59% total forest cover within 300 feet of streams and waterbodies (Purser and Simmonds, 2002).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Data Gap

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			**4. Water Quality**		
1.1	Fish Passage	X	4.1	Water quality standards	
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness	X	4.4	Bull trout temperature requirement	
2.2	Fine sediment	X		Data gap	X
2.3	Actively eroding banks		**5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD**		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap		5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area	X		Data gap	X
3.2	Annual hydrograph characteristics		**6. Shoreline Condition and Floodplain Connectivity**		
	Data gap		6.1	Shoreline hardening and overwater structures	
				Data gap	X

Woods Creek – Lower (RM 3.7 – Mainstem Skykomish RM 4.3)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Moderately Degraded
Data from a 1996 culvert survey by Washington Trout show that three tributaries in lower Woods Creek may have blockage at low flows (Washington Trout, 2001).

Habitat Condition 2. Sediment
Degraded
Woods Creek carries high levels of sediment during storm events (Cusimano and Coots, 1997). A 1984 physical stream survey by the Tulalip Tribes documents the presence of high percentages sand and silts in spawning gravel throughout the subwatershed (Thorn et al., 1992). Cobble embeddedness is greater than 35% throughout the entire Woods Creek subwatersheds (Woods Creek, Woods Creek-lower, and Woods Creek-West Fork), exceptions being in higher gradient reaches where scour occurs (Thorn et al., 1992).

Habitat Condition 3. Hydrology
Degraded
Total impervious area in lower Woods Creek is estimated at 12.5% (Purser and Simmonds, 2002). High levels of impervious surfaces occur in the lower watershed, while low levels of impervious surfaces occur in the contributing drainages.

Habitat Condition 4. Water Quality
Moderately Degraded
In August 1999, the average temperature for 19.4 days in Richardson Creek averaged 15.84^{o} C (59.8^{o} F). For 30 days in September, the average temperature was 14.21^{o} C (57.6^{o} F) (Tulalip Tribes, unpublished data). Woods Creek problems are listed as fecal coliform bacteria and fine sediment (Thornburgh, 1996).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Data Gap
Lower Woods Creek subwatershed has 26% mixed forest, 0% mature evergreen forest, and 26% total forest cover within 300 feet of streams and waterbodies (Purser and Simmonds, 2002).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Data Gap

The performance criteria checked below are applied in the assessment of this subwatershed						
1. In-stream Artificial Barriers to Habitat				4. Water Quality		
1.1	Fish Passage	X		4.1	Water quality standards	X
	Data Gap			4.2	Sediment quality	
2. Sediment				4.3	Salmonid temperature requirement	X
2.1	Embeddedness	X		4.4	Bull trout temperature requirement	
2.2	Fine sediment	X			Data gap	
2.3	Actively eroding banks			5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs			5.1	Shoreline buffer	
2.5	Sediment transport			5.2	Wetland, estuarine, and nearshore reserves	
	Data gap			5.3	Large woody debris	
3. Hydrology				5.4	Average stem diameter	
3.1	Total impervious area	X			Data gap	X
3.2	Annual hydrograph characteristics			6. Shoreline Condition and Floodplain Connectivity		
	Data gap			6.1	Shoreline hardening and overwater structures	
					Data gap	X

Woods Creek – West Fork (headwaters – lower Woods RM 3.7)
Skykomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
Data from a 1996 culvert survey by Washington Trout show 14 tributaries on the West Fork may have blockage at low flows (Washington Trout, 2001). The assessment of "degraded" is made because of the large number of tributaries impacted by low flow blockages.

Habitat Condition 2. Sediment
Degraded
Pebble count data from the Tulalip Tribes show fine sediment levels for Sister of Friar Creek at 19.61%, Sorgenfrei Creek at 17.78%, and Richardson Creek at 28.31% (grain size diameter is less than 2mm) (Tulalip Tribes, unpublished data). A 1984 physical stream survey by the Tulalip Tribes documents the presence of high percentages of sand and silts in spawning gravel throughout the subwatershed, although embeddedness is not specified (Thorn et al., 1992). Cobble embeddedness was greater than 35% throughout the entire Woods Creek subwatersheds (Woods Creek, Woods Creek-lower, and Woods Creek-West Fork), exceptions being in higher gradient reaches where scour occurs (Thorn et al., 1992).

Habitat Condition 3. Hydrology
Intact
West Fork maintains year-round flow even during drought conditions (Thorn et al., 1992). The total impervious area of West Fork Woods Creek is estimated to be five percent (Purser and Simmonds, 2002).

Habitat Condition 4. Water Quality
Data Gap
West Fork has been placed on the 303(d) listing for fecal coliform in 1998. Twelve percent of samples collected between 1992-1995 show exceedances beyond the upper criterion at station WCWF. The problems in Woods Creek are listed as fecal coliform bacteria and sediment (Thornburgh, 1996).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Data Gap
West Fork Woods Creek has 45% mixed forest, 0% mature evergreen forest, and 45% total forest cover within 300 feet of streams and waterbodies (Purser and Simmonds, 2002). While there is little mature evergreen forest, there is a relatively high percentage of mixed forest.

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Data Gap

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness	X	4.4	Bull trout temperature requirement	
2.2	Fine sediment	X		Data gap	X
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap		5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area	X		Data gap	X
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap		6.1	Shoreline hardening and overwater structures	
				Data gap	X

Snoqualmie River Watershed Habitat Conditions

Ames Creek (headwaters – Mainstem Snoqualmie RM 16.5)

Snoqualmie River

Land ownership is 14% private timber and 86% private non-timber (King County Department of Development and Environmental Services, 2000).

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
Seven out of 22 culverts in this subwatershed are salmonid passage barriers, five are passable, and the other 10 are of unknown status (Glasgow, 2001).

Habitat Condition 2. Sediment
Data Gap

Habitat Condition 3. Hydrology
Intact
Total impervious area is estimated to be 5.5% (Purser and Simmonds, 2002).

Habitat Condition 4. Water Quality
Data Gap
There have been high fecal coliform bacteria levels in the past (Fricke, 1994). Although recent data are not available, the presence of horse farms in the subwatershed suggests the potential for ongoing fecal coliform bacteria and nutrient loading.

Habitat Condition 5. Wetlands / Riparian Zone and Shoreline Vegetation /LWD
Degraded
Seventy-two percent of stream miles are in cleared or early seral stage (Gersib et al., 1999). This means that there are either no trees or young trees in most of the riparian zone (i.e., the average stem diameter is less than 30cm dbh).

Habitat Condition 6. Shoreline Conditions and Floodplain Connectivity
Moderately Degraded
The lower two miles of Ames Creek have been significantly altered by channelization for agricultural purposes. The straightening of the creek has disconnected the active channel from its floodplain, thereby compromising natural floodplain processes. This translates to shoreline hardening or overwater structures affecting 10 - 20% of shorelines (Fuerstenberg, 2002).

The performance criteria checked below are applied in the assessment of this subwatershed						
1. In-stream Artificial Barriers to Habitat				4. Water Quality		
1.1	Fish Passage	X		4.1	Water quality standards	
	Data Gap			4.2	Sediment quality	
2. Sediment				4.3	Salmonid temperature requirement	
2.1	Embeddedness			4.4	Bull trout temperature requirement	
2.2	Fine sediment				Data gap	X
2.3	Actively eroding banks			5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs			5.1	Shoreline buffer	
2.5	Sediment transport			5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X		5.3	Large woody debris	
3. Hydrology				5.4	Average stem diameter	X
3.1	Total impervious area	X			Data gap	
3.2	Annual hydrograph characteristics			6. Shoreline Condition and Floodplain Connectivity		
	Data gap			6.1	Shoreline hardening and overwater structures	X
					Data gap	

Cherry Creek (headwaters – Mainstem Snoqualmie RM 6.3)
Snoqualmie River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
Thirty-nine of 84 inventoried culverts are fish passage barriers below the standards for fish passage established by WDFW. Furthermore, the Drainage District pump intake on lower Cherry Creek (just upstream of the Highway 203 bridge) is unscreened and is a significant source of mortality for several fish species (Glasgow, 2001).

Habitat Condition 2. Sediment
Data Gap

Habitat Condition 3. Hydrology
Intact
Total impervious area is estimated to be 3.5% (Purser and Simmonds, 2002).

Habitat Condition 4. Water Quality
Degraded
Water quality data collected by the Tulalip Tribes in 1999 indicate that the state water quality standards for fecal coliform bacteria and temperature were consistently exceeded at several sampling sites (McHugh, 1999). Fecal coliform bacteria counts and pH measurements have violated state water quality standards in the past. Nutrient levels have been elevated as well (WDOE, 1997a; Thornburgh et al., 1991; Fricke, 1995).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Numerous hillslope tributaries have been ditched and straightened across the valley floor to drain valley wetlands. Loss of native riparian forest structure and the simplification of the vegetation community have resulted in a significant loss of in-channel LWD and in potential recruitment of LWD (Glasgow, 2000).

Habitat Condition 6. Shoreline Conditions and Floodplain Connectivity
Degraded
The channel and floodplain of lower Cherry Valley have been simplified and disconnected from each other. Bank hardening from the extensive levee system and the straightening of the mainstem and floodplain tributaries have reduced the ability of the active channel to re-establish connection with its floodplain, compromising natural floodplain processes (Glasgow, 2001).

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	X
	Data gap	X	5.3	Large woody debris	X
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area	X		Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap		6.1	Shoreline hardening and overwater structures	X
				Data gap	

Coal Creek – Lower (Mainstem Snoqualmie RM 38.9 - 34.8)
Snoqualmie River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Data Gap

Habitat Condition 2. Sediment
Data Gap

Habitat Condition 3. Hydrology
Moderately Degraded
Total impervious area is estimated to be 7.5% (Purser and Simmonds, 2002).

Habitat Condition 4. Water Quality
Degraded
Total phosphorus levels and fecal coliform bacteria counts exceed Washington state water quality standards in some reaches of Kimball Creek, a tributary to lower Coal Creek (Herrera Environmental Consultants, 2000). Samples collected from six sites in Kimball Creek during 2001 baseflow conditions indicate consistently poorer water quality than in similar regional streams. The parameters that indicate poor water quality in Kimball Creek include dissolved oxygen, nutrients, and fecal coliform bacteria. There are frequent violations of Class A water quality standards for dissolved oxygen and fecal coliform bacteria, as well as elevated total phosphorus levels at some sampling sites (City of Snoqualmie, 2001).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Seventy percent of stream miles are in cleared or early seral stage (Gersib et al., 1999). This means that there are either no trees or young trees in most of the riparian zone (i.e., the average stem diameter is less than 30cm dbh).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Degraded
Sixty-four percent of floodplain miles are confined by shoreline hardening (Gersib et al., 1999).

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage		4.1	Water quality standards	X
	Data Gap	X	4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area	X		Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap		6.1	Shoreline hardening and overwater structures	X
				Data gap	

Coal Creek – Upper (N. Fork Snoqualmie RM 4.8 – Mainstem Snoqualmie RM 38.9)

Snoqualmie River (includes mainstem Snoqualmie River upstream of Snoqualmie Falls)

Habitat Condition 1. Instream Artificial Barriers to Habitat
Data Gap

Habitat Condition 2. Sediment
Data Gap

Habitat Condition 3. Hydrology
Moderately Degraded
Total impervious area is estimated to be eight percent (Purser and Simmonds, 2002).

Habitat Condition 4. Water Quality
Data Gap
Water quality is good in Brockway Creek (on east side of subwatershed) (Anderson, 2000).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Seventy percent of stream miles are in cleared or early seral stage (Gersib et al., 1999). This means that there are either no trees or young trees in most of the riparian zone (i.e., the average stem diameter is less than 30cm dbh).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Data Gap
There are 2.61 road crossings/mile of stream (Gersib et al., 1999). Reinig Road and Mill Pond Road (which are a continuation of Highway 202) run through a portion of this subwatershed. These major roads likely contribute to a loss of floodplain connectivity.

The performance criteria checked below are applied in the assessment of this subwatershed

1. In-stream Artificial Barriers to Habitat		
1.1	Fish Passage	
	Data Gap	X
2. Sediment		
2.1	Embeddedness	
2.2	Fine sediment	
2.3	Actively eroding banks	
2.4	Feeder bluffs	
2.5	Sediment transport	
	Data gap	X
3. Hydrology		
3.1	Total impervious area	X
3.2	Annual hydrograph characteristics	
	Data gap	

4. Water Quality		
4.1	Water quality standards	
4.2	Sediment quality	
4.3	Salmonid temperature requirement	
4.4	Bull trout temperature requirement	
	Data gap	X
5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
5.1	Shoreline buffer	
5.2	Wetland, estuarine, and nearshore reserves	
5.3	Large woody debris	
5.4	Average stem diameter	X
	Data gap	
6. Shoreline Condition and Floodplain Connectivity		
6.1	Shoreline hardening and overwater structures	
	Data gap	X

Griffin Creek (headwaters – Mainstem Snoqualmie RM 26.4)

Snoqualmie River

Most of the land in this subwatershed is managed for timber production. In lower Griffin Creek, there is some agricultural and suburban residential land use.

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
The WDFW culvert database reports six culverts surveyed by Washington Trout in the subwatershed. Two are known to hinder fish passage in tributaries to Griffin Creek. Fish passage through the other four culverts is rated as unknown (WDFW, 2002). The database was not reviewed for fishways and dams.

The Washington Department of Natural Resources found that 76% of surveyed culverts are fish passage impediments. Some of these culverts are seasonally impassable, while others are totally impassable (Weyerhaeuser, 1995)

Habitat Condition 2. Sediment
Degraded
Griffin Creek is impacted by the 26000 road—fine sediment from the road and erosion from the road prism impacts spawning gravel quality (Weyerhaeuser, 1995). The JML and 26900 roads deliver fine sediments to Upper Griffin Creek and Grizzley Creek (a tributary to Griffin Creek), impacting spawning gravel quality (Weyerhaeuser, 1995). Upper Griffin Creek receives 269.3 tons/year of sediment from road erosion (Weyerhaeuser, 1995). Areas in lower Griffin Creek subwatershed are susceptible to mass wasting events due to the removal of lateral slope support by road cuts, oversteepened cut banks, and poor road drainage. Lower Griffin Creek receives 96.7 tons/year of sediment from road erosion (Weyerhaeuser, 1995).

The stream bank slopes on lower Griffin Creek range from 20 - 60%. Forty percent of the banks in the lower three miles of Griffin Creek are actively eroding.

The 28.4 acre wetland at RM 9 is important rearing habitat for coho salmon. It is affected by sediment input from roads 26000, 26200, 26700 and various spur roads. It receives approximately 2.2 metric tons of sediment from the road network each year, a chronically detectable amount (Weyerhaeuser, 1995).

Habitat Condition 3. Hydrology
Data Gap
The flows in the subwatershed are rain dominated and no portion lies in the rain-on-snow zone. Griffin Creek flows are stabilized by a large wetland system at RM 9. In the summer, the wetland will reach an elevation threshold and cease flowing as a surface water contribution to the stream. Baseflows are groundwater contributed from the wetland and surrounding hillsides (Savery, 2001). Portions of Griffin Creek flow subsurface in the summer.

Habitat Condition 4. Water Quality
Intact
There are no 303(d) listed segments (WDOE, 2000). Single point temperatures collected in Griffin Creek ranged from 12.3 to 12.6° C and dissolved oxygen ranged from 9.7 to 10.5 mg/L (O'Neal, 2000). Past temperature and dissolved oxygen measurements have generally met Washington state water quality standards. There is no evidence that nutrient levels impair water quality in this subwatershed (Weyerhaeuser, 1995).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Moderately Degraded
All the riparian vegetation on Griffin Creek was harvested in the late 1920s-early 1930s. The 26000 road borders the right bank of Griffin Creek and restricts the width of the riparian zone to less than one SPT. The lower five miles of Griffin Creek (excluding the portion that flows on the Snoqualmie River floodplain) have regenerated deciduous dominated stands. The understory in most of these stands consists of young shade tolerant species like cedar and hemlock (Weyerhaeuser, 1995). Currently, recruitment is limited to alders. The middle and upper portions of the stream have conifer dominated stands of varying age.

LWD counts on four stream segments with channel width less than 10m wide were all greater than 0.5 pieces/channel width ("intact"). LWD counts on lower Griffin Creek in channels 10-20m wide were 0.13 pieces/channel width ("degraded") (Weyerhaeuser, 1995).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Moderately Degraded
A logging road that runs alongside most of Griffin Creek contributes to loss of floodplain connectivity. Approximately 10% of the shoreline (1.39 river miles) are affected by road encroachment (Savery, in prep.). The lower five miles of Griffin Creek have less channel complexity (e.g., less roughness) and therefore less rearing and refuge habitat than elsewhere in the subwatershed (Weyerhaeuser, 1995).

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			**4. Water Quality**		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment	X		Data gap	
2.3	Actively eroding banks	X	**5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD**		
2.4	Feeder bluffs		5.1	Shoreline buffer	X
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap		5.3	Large woody debris	X
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area			Data gap	
3.2	Annual hydrograph characteristics		**6. Shoreline Condition and Floodplain Connectivity**		
	Data gap	X	6.1	Shoreline hardening and overwater structures	X
				Data gap	

Harris Creek (headwaters – Mainstem Snoqualmie RM 20.4)
Snoqualmie River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
Seventeen out of 36 culverts surveyed in the subwatershed are salmonid passage barriers—three of these are on the mainstem. Ten are passable and nine are unknown (Glasgow, 2001).

Habitat Condition 2. Sediment
Data Gap

Habitat Condition 3. Hydrology
Intact
Total impervious area is estimated to be 6.5% (Purser and Simmonds, 2002).

Habitat Condition 4. Water Quality
Data Gap
N.E. Stillwater Road runs along three miles of Harris Creek. There are numerous dairy and horse farms. Stormwater runoff from increased development is an ongoing source of water pollution.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Seventy-one percent of stream miles are in cleared or early seral stage (Gersib et al., 1999). This means that there are either no trees or young trees in most of the riparian zone (i.e., the average stem diameter is less than 30cm dbh).

From the mouth to the old railroad grade, riparian conditions are good. The reach from the railroad grade to Highway 203 has recently been platted and riparian conditions are fair. From Highway 203 to Stossel Creek Road, riparian conditions are good. Along the full length of Stossel Creek Road, the road and stream are in the same floodplain alignment and riparian conditions are severely impaired (Anderson, 2002).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Moderately Degraded
Harris Creek currently has a moderately natural shoreline (i.e., shoreline hardening or overwater structures do not affect greater than 20% of shorelines) (Anderson, 2000).

Shoreline condition and floodplain connectivity are “moderately degraded” in this subwatershed because of 2.24 road crossings/mile of stream (Gersib et al., 1999), increased rural residential development, and Stossel Creek Way along two miles of upper Harris Creek.

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			**4. Water Quality**		
1.1	Fish Passage	X	4.1	Water quality standards	
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	X
2.3	Actively eroding banks		**5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD**		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area	X		Data gap	
3.2	Annual hydrograph characteristics		**6. Shoreline Condition and Floodplain Connectivity**		
	Data gap		6.1	Shoreline hardening and overwater structures	X
				Data gap	

Patterson Creek (headwaters – Mainstem Snoqualmie RM 29.8)

Snoqualmie River

Land ownership is 80.1% private non-timber (King County Department of Development and Environmental Services, 2000)

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
Twenty-two out of 38 culverts in this subwatershed are salmonid passage barriers, seven culverts are passable, and the other nine are of unknown status (Glasgow, 2001). Barriers formed by perched culverts at RM 8.8 prevent access by anadromous fish to the uppermost reaches of Patterson Creek (King County SWM, 1993).

Habitat Condition 2. Sediment
Degraded
Development in the upland plateau creates severe erosion problems in tributaries to Patterson Creek. The sediment, including fine sediment, that is eroded from these tributary channels is deposited in the mainstem of Patterson Creek. The mainstem channel has insufficient slope to transport the full sediment load. Increased sediment production as a result of increased upland development will result in an increased rate of sedimentation in the mainstem channel (King County SWM, 1993).

Habitat Condition 3. Hydrology
Intact
Total impervious area is estimated to be 6.5% (Purser and Simmonds, 2002).

Habitat Condition 4. Water Quality
Degraded
Patterson Creek has a variety of nonpoint pollution problems associated with agricultural and residential land uses. Metals, nutrients, fecal coliform bacteria, and sediments are the most significant pollutants. Discharge of runoff from urban development into the erosion-sensitive plateau tributaries contributes to turbidity problems. S.E. Redmond-Fall City Road (Highway 202) runs along several miles of Patterson Creek and significant traffic volumes occur on the other roads in the subwatershed. Automobile traffic can be a significant source of copper and lead. High copper and/or lead concentrations that exceed state water quality standards were found at five of 14 sampling sites in Patterson Creek. High phosphorus and/or nitrate+nitrite concentrations that exceeded state water quality standards were found at eight of 14 sampling sites in Patterson Creek (King County SWM, 1993).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
LWD is sparse both in and adjacent to the creek (King County SWM, 1993). The frequency is less than 0.15 piece/channel width for much of the subwatershed.

Seventy-seven percent of stream miles are in cleared or early seral stage (Gersib et al., 1999). This means that there are either no trees or young trees in most of the riparian zone (i.e., the average stem diameter is less than 30cm dbh).

Land clearing for agricultural uses and subsequent dredging and deepening of the creek to reduce water levels have changed the wetlands profoundly. Much of the creek is overrun with reed canarygrass and yellow iris, eliminating the native wetland grasses, sedges, and rushes (King County SWM, 1993).

Habitat Condition 6. Shoreline Conditions and Floodplain Connectivity
Data Gap
S.E. Redmond-Fall City Road (Highway 202) runs along or crosses the creek at many locations.

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment	X		Data gap	
2.3	Actively eroding banks	X	5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	X
	Data gap		5.3	Large woody debris	X
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area	X		Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap		6.1	Shoreline hardening and overwater structures	
				Data gap	X

Pratt River (headwaters – lower Middle Fork Snoqualmie RM 16.1)
Snoqualmie River (above Snoqualmie Falls)

Habitat Condition 1. Instream Artificial Barriers to Habitat
Data Gap

Habitat Condition 2. Sediment
Data Gap
Mass wasting potential from human activities such as road construction and timber harvest is low in 99% of the Pratt River subwatershed. However, a large mass failure about 0.5 miles upstream from the mouth of the Pratt River contributes large amounts of fine sediments to the river (USFS, 1998b).

Habitat Condition 3. Hydrology
Data Gap
Approximately 95% of the vegetation in the Pratt River subwatershed is hydrologically mature (USFS, 1998b).

Habitat Condition 4. Water Quality
Data Gap
Frequent high turbidity loads have been visually observed in the lower Pratt River for a decade. However, turbidity has not been monitored (USFS, 1998b).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Intact
Only 13% of stream miles are in cleared or early seral stage (Gersib et al., 1999). Since there is mid seral or late seral vegetation along 87% of stream miles, it can be assumed that the average stem diameter of the riparian zone and shoreline vegetation is greater than 50cm dbh.

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Intact
There is no floodplain decoupling or channel confinement (Gersib et al., 1999). Therefore, it can be assumed that shoreline hardening or overwater structures affect less than 10% of shorelines.

There is less than one (0.34) road crossing/mile of stream (Gersib et al., 1999).

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			**4. Water Quality**		
1.1	Fish Passage		4.1	Water quality standards	
	Data Gap	X	4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	X
2.3	Actively eroding banks		**5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD**		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area			Data gap	
3.2	Annual hydrograph characteristics		**6. Shoreline Condition and Floodplain Connectivity**		
	Data gap	X	6.1	Shoreline hardening and overwater structures	X
				Data gap	

Raging River (headwaters – Mainstem Snoqualmie RM 34.8)
Snoqualmie River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
On a tributary to the Raging River (approximately 300 feet from the intersection with the Preston-Fall City Road), Lake Alice Road has a 48 - 56-inch perched culvert with sand-bagged margins. It is a barrier at a range of flows. There are three other barriers to fish passage in tributaries to the Raging River: a culvert at RM 0.12 of Soderman Creek and culverts at RM 1.2 and RM 1.48 of Lake Creek. These culverts block access to various life stages of coho and steelhead (WDFW, 2002; McHugh, 2001).

Habitat Condition 2. Sediment
Moderately Degraded
An investigation of the intrusion of fines in salmon redds was conducted on the Raging River. The study involved placing 78 artificial redds (egg boxes) in the river and retrieving them after a period of time. An average of 14.6 percent surface fines are less than 0.85mm in the egg boxes (data from DeVries et al., 2001).

Dunne estimates total sediment load to be 6,000 tons/year, bedload to be 600 tons/year, and suspended load to be 5,400 tons/year (Dunne, 1979).

Habitat Condition 3. Hydrology
Data Gap
The proximity of Preston-Fall City Road to the Raging River for the lowest 4.6 miles of this subwatershed and the I-90 and Highway 18 crossings of the Raging River (King County DNR, 2001a) suggest ongoing sources of stormwater runoff that could alter peak flow and/or flow timing.

Past timber harvest in this subwatershed may be causing problems with low flows (Pentec and NW GIS, 1999) and increased peak flows (Lucchetti, 2002). A significant portion of the subwatershed is in the rain-on-snow zone—exacerbating the effects of timber harvesting on hydrology (Lucchetti, 2002).

Habitat Condition 4. Water Quality
Data Gap
The proximity of Preston-Fall City Road to the Raging River for 4.6 miles from I-90 to Highway 202 (King County DNR, 2001a) suggests an ongoing source of stormwater runoff that could transport sediment, nutrients, and other pollutants to the river.

Elevated fecal coliform levels, temperature, and pH have been measured in the past (Fricke, 1995).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
There is a narrow band of riparian vegetation in the lower Raging River near the confluence with the mainstem Snoqualmie River. The upper watershed, including tributaries such as Deep Creek, is largely second growth forest with limited potential for near-term LWD recruitment (timber ages vary—much of it is 40-50 years old) (Herrera Environmental Consultants, 1995).

Logging, residential development, recreation, and road construction have reduced the amount of mature forested riparian area and, therefore, the potential for LWD recruitment in the lower Raging River. Several bridges over the Raging River impair the transport of LWD throughout the system. LWD formerly present in the river was removed for flood protection and navigation. Due to diking and past LWD removal, there is a paucity of LWD in the lower Raging River. For example, during a stream survey of 3,833 feet from the confluence upstream, only nine logs were observed in the wetted channel (Herrera Environmental Consultants, 1995)

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Degraded
The lower 4.6 miles of the Raging River (out of a total of 15 miles in the mainstem Raging River) exhibit highly constrained and degraded channel and floodplain conditions. From the mouth to RM 1.4, the Raging River is encased in continuous levees topped by access roads. These levees prevent the channel from meandering and developing side channels, and also cut off wetlands (Herrera Environmental Consultants, 1995). There is intermittent armoring from RM 1.4 upstream to I-90, and much of the river bank (particularly adjacent to the trailer park) from I-90 to Highway 18 is armored. The proximity of Preston-Fall City Road to the river from I-90 downstream to Highway 202 also contributes to loss of channel/shoreline complexity and floodplain connectivity. There is virtually no off-channel habitat downstream of I-90.

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment	X		Data gap	X
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	X
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap		5.3	Large woody debris	X
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area			Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap	X	6.1	Shoreline hardening and overwater structures	X
				Data gap	

Snoqualmie River – Mouth (RM 9.8 – Mainstem Snohomish RM 19.6)
Snoqualmie River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded

No barriers exist along the mainstem. Artificial barriers exist, however, in the form of flood-gates and dikes at or near the mouths of tributaries. Tributaries with barriers include Riley Slough, Cocker Creek, and Pearson Eddy Creek (Snohomish County PDS, 1999). There are no artificial barriers at Peoples Creek or "Honor Creek" (drainage from west slopes of High Rock Quarry through the Monroe Correctional Facility). Habitat in tributaries above blockages could provide rearing for multiple species and limited coho and cutthroat spawning if barriers are addressed.

Habitat Condition 2. Sediment
Data Gap

Primarily because of the very low gradient in the mainstem in the Snoqualmie Mouth subwatershed (and perhaps exacerbated by adjacent and upstream land use), substrate in the reach is sand and silt dominated, and suitable gravels for salmonid spawning are limited. Cattle access significant portions of the eastern shore and right bank tributaries, contributing to bank erosion.

Habitat Condition 3. Hydrology
Intact

Total impervious area is estimated to be six percent (Purser and Simmonds, 2002). However, it should be noted that extensive forest clearing may impact the hydrologic regime of tributary streams.

Habitat Condition 4. Water Quality
Degraded

Several tributaries draining the eastern slopes of the floodplain that flow through farmland are temperature and dissolved oxygen limited during summer months (e.g., Riley Slough and Honor Creek) to an extent that would preclude salmonid use for rearing or migration (Snohomish County PDS, 1999). The lower Snoqualmie River on the 303(d) list for high temperatures (WDOE, 1998). Fecal coliform levels also commonly exceed state standards (Thornburgh and Williams, 2000).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded

Twenty-five percent of the Snoqualmie River shoreline has a greater than 200-foot forested buffer, while 60% has only grass, brush, or a single line of trees (left and right banks combined) (Pentec and NW GIS, 1999). Eighty-six percent of riparian stands along the mainstem are cleared or in early seral stage (Gersib et al., 1999). Wood loading is nearly non-existent in tributaries in the mainstem floodplain. Further upstream along left bank tributaries, wood loading is considered good (Snohomish County PDS, 1999). The riparian vegetation along tributaries in the floodplain relative to natural species assemblage is less than 25% (Snohomish County PDS, 1999). The 3.3 miles of stream bank in Riley Slough has no vegetated riparian zone (Michalak, in prep.). The subwatershed contains no mature evergreen forest and only 26% mixed forest (Purser and Simmonds, 2002).

Habitat Condition 6. Shoreline Condition and Floodplain Connection
Degraded
Forty percent of the channel has been confined and 71% of the floodplain has been decoupled from historic conditions (Gersib et al., 1999).

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	X
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	X
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area	X		Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap		6.1	Shoreline hardening and overwater structures	X
				Data gap	

Snoqualmie River – Mid-Mainstem (RM 23.9 – Mouth Snoqualmie RM 9.8)
Snoqualmie River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
The King County Department of Transportation conducted a culvert survey and identified 21 culverts in the Mid-Mainstem Snoqualmie subwatershed that are fish passage barriers below the standards established by the Washington Department of Fish and Wildlife (Fritz, 2001).

Habitat Condition 2. Sediment
Moderately Degraded
King County conducted a habitat conditions inventory on the mainstem Snoqualmie River in summer 2000. The GPS data from this field work and low elevation aerial photos from spring 2001 reveal heavy erosion along streambanks where human or cattle access the river. Erosion occurs on 785 meters of the left bank and on 2,667 meters of the right bank, representing 11.7% of the banks (King County DNR, 2001b; King County DNR, 2001c).

Dunne estimates the total sediment load to be 400,000 tons/year, bedload to be 20,000 tons/year, and suspended load to be 380,000 tons/year in the Snoqualmie River at Carnation (Dunne, 1979).

Habitat Condition 3. Hydrology
Moderately Degraded
Total impervious area is estimated to be eight percent (Purser and Simmonds, 2002).

The August instream flow requirement exceeds both the average and the median seven-day low flow measured at the Snoqualmie River hydrology gage near Carnation. Low flows naturally occur in the mid-mainstem Snoqualmie River during late summer, but are exacerbated by water withdrawals and residential and agricultural land use (Pentec and NW GIS, 1999). Peak flows may be exacerbated by extensive surface water runoff from two major roads (Highway 203 and West Snoqualmie Valley Road) that run the length of this subwatershed. The unincorporated town of Fall City and the cities of Snoqualmie and North Bend all extract well and spring water from this subwatershed above the gage near Carnation (Pentec and NW GIS, 1999). Increased land development (with resultant increased demands for water withdrawal and increased impervious area) in this subwatershed are likely to further degrade the current hydrologic regime.

Habitat Condition 4. Water Quality
Degraded
Several segments of the mainstem Snoqualmie River are on the final 1998 Section 303(d) list based on elevated temperature (WDOE, 2000). Lack of riparian cover and slow moving water in the channelized lower reaches of the river contribute to elevated temperature. Other water quality parameters that have not met state water quality standards in the past are dissolved oxygen, fecal coliform bacteria, and pH. Nutrient levels have been elevated as well (Fricke, 1995; Joy, 1994; Ehinger, 1993; Joy et al., 1991; Thornburgh et al., 1991).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Only 25% of the Snoqualmie River has 200 feet or more of forested buffer along the banks. By contrast, 60% has grass, brush or a single line of trees (Pentec and NW GIS, 1999). Much of the vegetation is non-native species such as Himalayan blackberry and Japanese knotweed.

Degraded shoreline vegetation results in low recruitment of LWD to the river. Summer 2000 fieldwork revealed an overall paucity of LWD in the mid-mainstem Snoqualmie River (i.e., 471 pieces of wood in 18 miles) (King County DNR, 2001b). This translates to less than one piece of LWD/channel width greater than 20 meters wide. The existing LWD is old.

Large trees are found along only 2.8% of river miles on the left bank and 8.9% of river miles on the right bank of the mid-mainstem Snoqualmie River (King County DNR, 2001b). The average stem diameter is less than 30cm dbh.

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Degraded
There is shoreline hardening (revetments) on 31.6% of river miles on the left bank and 25.4% of river miles on the right bank of the mid-mainstem Snoqualmie River (King County DNR, 2001b).

Riverbanks that are hardened with small riprap and compacted soil dikes provide little cover for fish and reduce the amount of suitable refuge habitat. Most dikes in the mid-mainstem Snoqualmie fall into this category (Pentec and NW GIS, 1999).

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	X
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	
2.3	Actively eroding banks	X	5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	X
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap		5.3	Large woody debris	X
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area	X		Data gap	
3.2	Annual hydrograph characteristics	X	6. Shoreline Condition and Floodplain Connectivity		
	Data gap		6.1	Shoreline hardening and overwater structures	X
				Data gap	

Snoqualmie River – Upper Mainstem (RM 34.8 to Mid-Main. Snoqualmie RM 23.9)
Snoqualmie River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
The King County Department of Transportation conducted a culvert survey and identified 20 culverts that are fish passage barriers below the standards for fish passage established by the WDFW (Fritz, 2001).

Habitat Condition 2. Sediment
Moderately Degraded
King County conducted a habitat conditions inventory on the mainstem Snoqualmie River in summer 2000. The GPS data from this field work and low elevation aerial photos from spring 2001 reveal heavy erosion along streambanks where humans or cattle have access to the river. There is erosion on 1,108 meters of the left bank and 1,023 meters of the right bank, representing 10.2% of the banks (King County DNR, 2001b; King County DNR, 2001c).

Dunne estimates the total sediment load to be 400,000 tons/year, bedload is 20,000 tons/year, and suspended load is 380,000 tons/year in the Snoqualmie River at Carnation (Dunne, 1979).

Habitat Condition 3. Hydrology
Moderately Degraded
Total impervious area is estimated to be seven percent (Purser and Simmonds, 2002).

There is an instream flow requirement of 700 cfs for August through September and 2,800 cfs for November through June (Washington Administrative Code, Chapter 173-507). The August instream flow requirement exceeds both the average and the median seven-day low flow measured at the Snoqualmie River hydrology gage near Snoqualmie. Low flows occur naturally in the upper mainstem Snoqualmie River during late summer (Pentec and NW GIS, 1999). There is not much "cushion" to absorb the impacts of further land development. High flows may be exacerbated by extensive surface water runoff from three major roads (Highway 203, Highway 202, and West Snoqualmie Valley Road) that run the length of or along a major portion of this subwatershed. Increased land development and forest practices in and upstream of this subwatershed and the resultant increased impervious area could change the current hydrologic regime from “moderately degraded” to “degraded”.

Habitat Condition 4. Water Quality
Degraded
Several segments of the mainstem Snoqualmie River are on the final 1998 Section 303(d) list based on elevated temperature that does not meet the state water quality standards for temperature (WDOE, 2000). Other water quality parameters that have not met state water quality standards in the past are dissolved oxygen, fecal coliform bacteria, and pH. Nutrient levels have been elevated as well (Fricke, 1995; Joy, 1994; Ehinger, 1993; Lane, 1993; Joy et al., 1991; Thornburgh et al., 1991).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Only 25% of the Snoqualmie River between Fall City and Duvall has 200 feet or more of forested buffer along the banks. By contrast, 60% has grass, brush or a single line of trees (Pentec and NW GIS, 1999). Much of the vegetation is non-native species such as Himalayan blackberry, reed canary grass, and Japanese knotweed.

Degraded shoreline vegetation results in low recruitment of LWD to the river. Summer 2000 fieldwork revealed an overall lack of LWD in the upper mainstem Snoqualmie River from the Tolt River confluence to the Tokul Creek confluence (i.e., 351 pieces of wood in 13.5 miles) (King County DNR, 2001b). This translates to less than one piece of LWD/channel width greater than 20 meters wide. The existing LWD is old.

Large trees are found along only 0.5% of river miles on the left bank and 9.2% of river miles on the right bank of the upper mainstem Snoqualmie (King County DNR, 2001b). The average stem diameter is less than 30cm dbh.

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Degraded
There is shoreline hardening (revetments) on 37.9% of river miles on the left bank and on 31.8% of river miles on the right bank of the upper mainstem Snoqualmie River (King County DNR, 2001b). Extensive bank hardening in this subwatershed limits the creation of summer rearing habitat and winter refuge habitat (Pentec and NW GIS, 1999).

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	X
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	
2.3	Actively eroding banks	X	5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	X
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap		5.3	Large woody debris	X
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area	X		Data gap	
3.2	Annual hydrograph characteristics	X	6. Shoreline Condition and Floodplain Connectivity		
	Data gap		6.1	Shoreline hardening and overwater structures	X
				Data gap	

Snoqualmie River – Lower South Fork (RM 9.6 – Mainstem Snoqualmie RM 42)

Snoqualmie River (above Snoqualmie Falls for approximately 11 river miles to U.S. Forest Service boundary)

The land in this subwatershed is rural residential (in and near North Bend) and private timber ownership.

Habitat Condition 1. Instream Artificial Barriers to Habitat
Data Gap

Habitat Condition 2. Sediment
Data Gap
Review of aerial photographs and road inventories indicates contributions of sediment from road failures, streambank erosion, and dam-break floods (USFS, 1995b).

For the lower Middle, lower North, and lower South Forks of the Snoqualmie River, Dunne estimates the total sediment load to be 360,000 tons/year in the Snoqualmie River at Snoqualmie (Dunne, 1979).

Habitat Condition 3. Hydrology
Moderately Degraded
Total impervious area is estimated to be 8.5% (Purser and Simmonds, 2002). Two-year peak flows exceed pre-disturbance ten-year peak flows (Gersib et al., 1999).

Habitat Condition 4. Water Quality
Degraded
The South Fork Snoqualmie River is on the final 1998 Section 303(d) list for temperature and pH (WDOE, 2000). The proximity of I-90 for about three miles of the South Fork in this subwatershed may result in an elevated level of toxic chemicals and other pollutants in the river.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Sixty-two percent of stream miles are in cleared or early seral stage (Gersib et al., 1999). This means that there are either no trees or young trees in most of the riparian zone (i.e., the average stem diameter is less than 30cm dbh).

Habitat Condition 6. Shoreline Conditions and Floodplain Connectivity
Moderately Degraded
There are many levees and revetments on the banks of the lower South Fork Snoqualmie River between RM 2.0 and RM 6.5 (King County DNR, 2001a). Therefore, approximately 10 - 20% of shorelines have been hardened in this subwatershed. The proximity of I-90 for about three miles of the South Fork in this subwatershed contributes to loss of floodplain connectivity.

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			**4. Water Quality**		
1.1	Fish Passage		4.1	Water quality standards	X
	Data Gap	X	4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	X
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	
2.3	Actively eroding banks		**5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD**		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area	X		Data gap	
3.2	Annual hydrograph characteristics		**6. Shoreline Condition and Floodplain Connectivity**		
	Data gap		6.1	Shoreline hardening and overwater structures	X
				Data gap	

Snoqualmie River – Upper South Fork (headwaters – lower S. F. Snoqualmie RM 9.6)

Snoqualmie River (above Snoqualmie Falls, starting at U.S. Forest Service boundary)

The land in this subwatershed is in private timber or U.S. Forest Service ownership (King County DNR, 2001a).

Habitat Condition 1. Instream Artificial Barriers to Habitat
Data Gap

Habitat Condition 2. Sediment
Data Gap

Habitat Condition 3. Hydrology
Data Gap

Habitat Condition 4. Water Quality
Degraded
The South Fork Snoqualmie River is on the final 1998 Section 303(d) list for temperature and pH. (WDOE, 2000). The proximity of I-90 for the length of the South Fork in this subwatershed may result in an elevated level of toxic chemicals and other pollutants in the river.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Moderately Degraded
Forty-nine percent of stream miles are in cleared or early seral stage (Gersib et al., 1999). This means that there are either no trees or young trees in approximately half of the riparian zone and there are older, medium-sized or large trees in approximately half of the riparian zone. The average stem diameter is likely to be in the range of 30 - 50cm dbh.

Habitat Condition 6. Shoreline Conditions and Floodplain Connectivity
Moderately Degraded
Shoreline hardening or overwater structures affect approximately 10 - 20% of shorelines. Proximity of I-90 for the length of the South Fork in this subwatershed contributes to loss of floodplain connectivity. There are 1.97 road crossings/mile of stream (Gersib et al., 1999; King County DNR, 2001a).

The performance criteria checked below are applied in the assessment of this subwatershed		
1. In-stream Artificial Barriers to Habitat		
1.1	Fish Passage	
	Data Gap	X
2. Sediment		
2.1	Embeddedness	
2.2	Fine sediment	
2.3	Actively eroding banks	
2.4	Feeder bluffs	
2.5	Sediment transport	
	Data gap	X
3. Hydrology		
3.1	Total impervious area	
3.2	Annual hydrograph characteristics	
	Data gap	X
4. Water Quality		
4.1	Water quality standards	X
4.2	Sediment quality	
4.3	Salmonid temperature requirement	X
4.4	Bull trout temperature requirement	
	Data gap	
5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
5.1	Shoreline buffer	
5.2	Wetland, estuarine, and nearshore reserves	
5.3	Large woody debris	
5.4	Average stem diameter	X
	Data gap	
6. Shoreline Condition and Floodplain Connectivity		
6.1	Shoreline hardening and overwater structures	X
	Data gap	

Snoqualmie River – Lower Middle Fork (RM 16.1 – N. Fork Snoqualmie RM 4.8)
Snoqualmie River (above Snoqualmie Falls)

Habitat Condition 1. Instream Artificial Barriers to Habitat
Moderately Degraded
Culverts in Middle Fork Snoqualmie Road that run alongside the Middle Fork Snoqualmie River may block access to tributaries during low flows (Anderson, 2001). The gravel road that accesses RM 56.3 to RM 57.7 (upstream of the confluence of Granite Creek and the Middle Fork Snoqualmie River) cuts across the existing tributary drainages. There are 30-inch diameter culverts under the road to maintain connectivity between the drainages that are dissected by the road. The culverts appear to be undersized with several of them wholly or partially blocked and several of them perched at the downstream end, thereby restricting fish access to the tributaries (U.S. Army Corps of Engineers, 2002).

Habitat Condition 2. Sediment
Data Gap
Mass wasting potential (resulting from road construction and clearcut timber harvest) is moderate in 11% and low in 89% of the lower Middle Fork Snoqualmie River subwatershed (USFS, 1998b).

Sediments generated in the upper watershed are primarily trapped above the falls in the low gradient three forks area. The Middle Fork is the largest contributor of sediments in the Snoqualmie Mainstem (WDFW, 1999). For the lower Middle, lower North, and lower South Forks of the Snoqualmie River, Dunne estimates the total sediment load to be 360,000 tons/year in the Snoqualmie River at Snoqualmie (Dunne, 1979).

Habitat Condition 3. Hydrology
Data Gap
Approximately 96% of the vegetation in the lower Middle Fork Snoqualmie River watershed is hydrologically mature (USFS, 1998b).

Habitat Condition 4. Water Quality
Data Gap
The Middle Fork Snoqualmie River was proposed for 303(d) listing in 1996 based on exceedances of the state water quality standards for temperature (WDOE, 1997a). Limited past sampling in the lower Middle Fork Snoqualmie showed exceedances of the state water quality standards for temperature and fecal coliform bacteria (Joy et al., 1991). Although the Middle Fork is not on the final 1998 303(d) list (WDOE, 2000), available data indicates that water temperature and dissolved oxygen levels may be limiting fish populations in some reaches of the lower Middle Fork. Furthermore, illegal dumping and dispersed camping are possible point sources of bacterial, hydrocarbon, and toxic contaminants (USFS, 1998b). There is no current data on water temperature, dissolved oxygen, and other water quality parameters in the lower Middle Fork.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
There are less than 50 pieces of LWD/mile of river (USFS, 1998b). This translates to less than one piece of LWD/channel width greater than 20 meters wide.

Forty-seven percent of stream miles along the Middle Fork Snoqualmie River are in cleared or early seral stage (i.e., shrub/seedlings and sapling/pole stands). The sapling/pole stands typically range from five to 20 years of age and one to nine inches (2.5 - 22.5cm) dbh. These trees will not provide quality LWD to the aquatic system for decades. Another 17% of stream miles have trees in the mid seral stage. Only 36% of stream miles have mature stands (USFS, 1998b).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Moderately Degraded
There are levees and revetments along the banks of the lower three miles of the Middle Fork Snoqualmie River (King County DNR, 2001a). This translates to shoreline hardening along 10 to 20% of shorelines in the lower Middle Fork Snoqualmie subwatershed. The levees and revetments eliminate natural streambank and create a disconnect between the river and associated off-channel floodplain habitat.

The Middle Fork Snoqualmie Road runs along the river through much of the valley. Overall road density is moderate for this subwatershed (USFS, 1998b).

The performance criteria checked below are applied in the assessment of this subwatershed

1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	X
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	X
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area			Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap	X	6.1	Shoreline hardening and overwater structures	X
				Data gap	

Snoqualmie River – Upper Middle Fork (headwaters–lower M.F. Snoq. RM 16.1)
Snoqualmie River (above Snoqualmie Falls)

Habitat Condition 1. Instream Artificial Barriers to Habitat
Data Gap
Culverts in logging roads in this subwatershed likely block access to tributaries during low flows (Anderson, 2001).

Habitat Condition 2. Sediment
Data Gap
Mass wasting potential (resulting from unsurfaced roads and timber harvest) is low in 66% and moderate in 32% of the upper Middle Fork Snoqualmie River subwatershed (USFS, 1998b).

Habitat Condition 3. Hydrology
Data Gap
Virtually 100% of the vegetation in the upper Middle Fork Snoqualmie River subwatershed is hydrologically mature.

There is not much human activity in the upper Middle Fork Snoqualmie River subwatershed that would impact base or peak flows. There are natural impervious conditions from rock and talus slopes (Anderson, May 2001).

Habitat Condition 4. Water Quality
Data Gap
Recent water quality data are not available. In fall 2000, thermographs were installed at several locations in the upper Middle Fork of the Snoqualmie River. The temperature data are expected to be downloaded in 2002 (King County DNR, 2001d).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Intact
The upper Middle Fork Snoqualmie River subwatershed includes U.S. Forest Service and Alpine Lakes Wilderness lands. Ninety-nine percent of these lands are covered by mid- and late seral forests. This suggests that the average stem diameter is greater than 50cm dbh. These mature trees recruit LWD into the river (USFS, 1998b).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Intact
There is no floodplain decoupling or channel confinement (Gersib et al., 1999). Therefore, it can be assumed that shoreline hardening or overwater structures affect less than 10% of shorelines.

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage		4.1	Water quality standards	
	Data Gap	X	4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	X
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area			Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap	X	6.1	Shoreline hardening and overwater structures	X
				Data gap	

Snoqualmie River – Lower North Fork (RM 16.1 – Mainstem Snoqualmie RM 42)

Snoqualmie River (above Snoqualmie Falls)

Much of the land in this subwatershed is maintained for timber production. Land use is rural in the lowermost part of the subwatershed near North Bend.

Habitat Condition 1. Instream Artificial Barriers to Habitat
Data Gap

Habitat Condition 2. Sediment
Data Gap
For the lower Middle, lower North, and lower South Forks of the Snoqualmie River, Dunne estimates the total sediment load to be 360,000 tons/year in the Snoqualmie River at Snoqualmie (Dunne, 1979).

Habitat Condition 3. Hydrology Regime
Data Gap

Habitat Condition 4. Water Quality
Data Gap
Past water quality sampling has shown that temperature, dissolved oxygen levels, and fecal coliform bacteria counts met state water quality standards (Joy et al., 1991; Joy, 1994). Recent water quality data are not available.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Data Gap
Due to past and ongoing logging, it is likely that the average stem diameter of trees in this subwatershed is less than 50cm dbh and that LWD recruitment is limited.

Habitat Condition 6. Shoreline Conditions and Floodplain Connectivity
Moderately Degraded
There are levees and revetments on the banks of most of the lower two miles of the North Fork Snoqualmie River (King County DNR, 2001a). This translates to 10 - 20% of shorelines being hardened.

There is an extensive network of logging roads in this subwatershed. Road density exceeds 3.26 miles of road/mile of stream and there are 1.33 road crossings/mile of stream (Gersib et al., 1999).

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			**4. Water Quality**		
1.1	Fish Passage		4.1	Water quality standards	
	Data Gap	X	4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	X
2.3	Actively eroding banks		**5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD**		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area			Data gap	X
3.2	Annual hydrograph characteristics		**6. Shoreline Condition and Floodplain Connectivity**		
	Data gap	X	6.1	Shoreline hardening and overwater structures	X
				Data gap	

Snoqualmie River – Upper North Fork (headwaters – lower N. Fork Snoqualmie 16.1)

Snoqualmie River (above Snoqualmie Falls)

The land in this subwatershed is maintained for timber production.

Habitat Condition 1. Instream Artificial Barriers to Habitat
Data Gap
Assessment of logging road culverts is needed to determine the extent of fish passage barriers.

Habitat Condition 2. Sediment
Data Gap

Habitat Condition 3. Hydrology
Data Gap
There are no current or future projected peak flow increases over pre-disturbance conditions (Gersib et al., 1999).

Habitat Condition 4. Water Quality
Data Gap
Past water quality sampling has shown that temperature, dissolved oxygen levels, and fecal coliform bacteria counts met state water quality standards (Joy et al., 1991; Joy, 1994). Recent water quality data are not available. In fall 2000, thermographs were installed at several locations in the upper North Fork of the Snoqualmie River. The temperature data are expected to be downloaded in 2002 (King County DNR, 2001d).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Data Gap
Due to past and ongoing logging, it is likely that the average stem diameter of trees in this subwatershed is less than 50cm dbh and that LWD recruitment is limited.

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Data Gap
This subwatershed has an extensive network of logging roads crossed by bridges. There are 1.12 road crossings/mile of stream (Gersib et al., 1999).

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage		4.1	Water quality standards	
	Data Gap	X	4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	X
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area			Data gap	X
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap	X	6.1	Shoreline hardening and overwater structures	
				Data gap	X

Tate Creek (headwaters – N. Fork Snoqualmie RM 0.3)

Snoqualmie River (upstream of Snoqualmie Falls)

90.8% of the Tate Creek subwatershed is in private timber ownership (King County Department of Development and Environmental Services, 2000).

Habitat Condition 1. Instream Artificial Barriers to Habitat
Data Gap

Habitat Condition 2. Sediment
Data Gap
Timber harvesting in this subwatershed may elevate sediment input to Tate Creek and/or its tributaries from steep, unstable slopes that no longer have tree roots to hold the soil and from surface erosion of logging roads.

Habitat Condition 3. Hydrology
Data Gap
There is only a two percent reduction in mean annual groundwater recharge from pre-disturbance to current conditions in this subwatershed and only a two percent further reduction in groundwater recharge projected from current to future conditions (Gersib et al., 1999).

Habitat Condition 4. Water Quality
Data Gap

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Eighty percent of stream miles are in cleared or early seral stage (Gersib et al., 1999). This means that there are either no trees or young trees in most of the riparian zone (i.e., the average stem diameter is less than 30cm dbh).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Data Gap
There are 2.06 road crossings/mile of stream (Gersib et al., 1999).

The performance criteria checked below are applied in the assessment of this subwatershed						
1. In-stream Artificial Barriers to Habitat				4. Water Quality		
1.1	Fish Passage			4.1	Water quality standards	
	Data Gap	X		4.2	Sediment quality	
2. Sediment				4.3	Salmonid temperature requirement	
2.1	Embeddedness			4.4	Bull trout temperature requirement	
2.2	Fine sediment				Data gap	X
2.3	Actively eroding banks			5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs			5.1	Shoreline buffer	
2.5	Sediment transport			5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X		5.3	Large woody debris	
3. Hydrology				5.4	Average stem diameter	X
3.1	Total impervious area				Data gap	
3.2	Annual hydrograph characteristics			6. Shoreline Condition and Floodplain Connectivity		
	Data gap	X		6.1	Shoreline hardening and overwater structures	
					Data gap	X

Taylor River (headwaters – upper Middle Fork Snoqualmie RM 19.8)
Snoqualmie River (upstream of Snoqualmie Falls)

Habitat Condition 1. Instream Artificial Barriers to Habitat
Data Gap

Habitat Condition 2. Sediment
Data Gap
Mass wasting potential from human activities such as road construction and timber harvest is low in 89% and moderate in nine percent of the Taylor River subwatershed (USFS, 1998b).

Habitat Condition 3. Hydrology
Data Gap
Approximately 94% of the vegetation in the Taylor River subwatershed is hydrologically mature (USFS, 1998b).

Habitat Condition 4. Water Quality
Data Gap

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Moderately Degraded
There are few large trees available for recruitment of LWD. There is a low frequency of LWD (approximately 20 pieces/mile of river) (USFS, 1998b). This translates to 0.2 - 0.5 pieces of LWD/channel width 10 - 20 meters wide.

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Intact
There is no floodplain decoupling or channel confinement (Gersib et al., 1999). Therefore, it can be assumed that shoreline hardening or overwater structures affect less than 10% of shorelines.

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage		4.1	Water quality standards	
	Data Gap	X	4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	X
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	X
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area			Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap	X	6.1	Shoreline hardening and overwater structures	X
				Data gap	

Tokul Creek (headwaters – Mainstem Snoqualmie RM 38)

Snoqualmie River

Ninety-six percent of the Tokul Creek subwatershed is in private timber ownership (King County Department of Development and Environmental Services, 2000).

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
Access to Tokul Creek is blocked by the WDFW hatchery diversion structure at RM 1. Historically, summer steelhead are not believed to have used the area above the barrier (Kraemer, 2002).

Habitat Condition 2. Sediment
Moderately Degraded
Timber harvest activities, road construction, filling in the floodplain, and bank hardening have contributed to increased sediment delivery to the creek from mass wasting, road erosion, and surface erosion of hillslopes (Weyerhaeuser, 1995). For example, a massive landslide between the WDFW Hatchery and Highway 202 continues to deliver significant amounts of fine sediment to the creek from the actively eroding bank.

Habitat Condition 3. Hydrology
Data Gap
There has been a four percent reduction in groundwater recharge from pre-disturbance to current conditions (Gersib et al., 1999).

Habitat Condition 4. Water Quality
Intact
There are no 303(d) listed segments (WDOE, 2000). Past temperature and dissolved oxygen measurements have generally met Washington state water quality standards (Weyerhaeuser, 1995).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Intact
Limited LWD counts show that the amount of LWD is variable spatially within Tokul Creek, but high overall. There were 2.1 LWD pieces/channel width in a 50m length and 15m width of river channel, and 1.8 LWD pieces/channel width in a 100m length and 20m width of river channel (Weyerhaeuser, 1995).

Tokul Creek has mature deciduous stands in the lower reaches and mature mixed and conifer dominated stands in the headwaters. The understories in the deciduous stands consist of immature conifers and are expected to dominate as the deciduous trees die. These conifer stands will provide a sustainable supply of LWD in the future. Overall, 76% of the riparian management zones in the Tokul Creek drainage have moderate to high near-term LWD recruitment potentials (32% and 44% respectively). Long-term LWD recruitment is high (Weyerhaeuser, 1995).

Habitat Condition 6. Shoreline Conditions and Floodplain Connectivity
Intact

Dikes, bank hardening, and other shoreline modifications in the lower reaches of Tokul Creek add up to approximately 0.5 mile or two percent of the approximately 26 miles of shoreline in this subwatershed. Between RM 0 - 0.5, there are two road crossings with associated bank hardening and concrete abutments. There are defunct bridge abutments within the channel at the Highway 202 crossing. There is an abandoned roadbed along the left bank downstream from the Tokul Creek hatchery. The right bank is hardened with riprap along the length of the hatchery property (Glasgow, 2002).

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	
2.3	Actively eroding banks	X	5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap		5.3	Large woody debris	X
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area			Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap	X	6.1	Shoreline hardening and overwater structures	X
				Data gap	

Tolt River – Lower (RM 8.4 – Mainstem Snoqualmie RM 23.9)
Snoqualmie River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Intact
Access for salmonids is generally provided at all flows. One culvert blocks a small tributary that is not considered anadromous habitat and another blocks a very small tributary that might support some juveniles (Washington Trout, 2001). The WDFW database indicates that these culverts block access for coho and resident trout (WDFW, 2002).

Habitat Condition 2. Sediment
Moderately Degraded
Three sediment samples collected in 2000 range from three to 10% fines (less than 0.85mm) in the subsurface sediment. McNeil samples collected in the mainstem Tolt River in previous years range from six to 16% fines. Of the ten samples, seven samples had 10% fines or less, two samples had between 11% and 15% fines, and one sample had greater than 15% fine sediment (Parametrix, 2001). The Parametrix report suggests that sediment delivery may be reduced by more than 70% over the next 50 years with scheduled road decommissioning and forest growth.

Otherwise, the mainstem Tolt is considered to have received excess sediment supply in the past several decades. This may influence its channel-forming capacity (Parametrix, 2001). Dunne estimates the total sediment load to be 70,000 tons/year, bedload to be 7,000 tons/year, and suspended load to be 63,000 tons/year near Carnation (Dunne, 1979).

Habitat Condition 3. Hydrology
Degraded
Mainstem Tolt River peak flows are reduced from 29% for flows exceeding a one-year event to 136% for a 100-year event by the South Fork Tolt Reservoir (Parametrix, Inc., 2001).

Habitat Condition 4. Water Quality
Intact
There are no 303(d) listed segments. Water quality data from WDOE stations on the lower Tolt and on the Snoqualmie near Carnation (Station 07D070, 1995, 1996) showed one exceedance of one criterion (temperature 18^{o} C) in August 1992 (WDOE, 2002).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Data Gap
The LWD supply in several reaches of the lower Tolt "is not what it could be because the mix of trees consists of smaller and less dense stems that do not last as long in the channel when compared to conditions along a more mature forest . . . LWD density in reaches B2 (RM 2.3 to 2.7) and C (RM 2.7 to 3.8) is now substantially greater than that seen in any portion of the lower Tolt River in 1936. However, even with this improvement in density, very little has accumulated in ways that create much-needed pool and side channel habitat" (Parametrix, 2001).

The majority of the mainstem riparian tree species within 70 feet of the channel are hardwoods, hardwoods mixed with young conifers, or solely young conifers. Average stem diameter is therefore less than 30cm dbh (WDNR, 1993).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Degraded
"After extension of levees to near RM 1.85, essentially all side-channels behind the levees were made inaccessible to juvenile salmonids. In 1998, reconnection of the lower end of the right bank Frew Creek side channel at about RM 0.62 reestablished about 1,300 lineal ft of spawning and rearing habitat. This is currently known to be used by coho and chum salmon, but it may also support some juvenile rearing by chinook as well" (Parametrix, 2001).

As more than two miles of this river section are diked, more than 20% of the reach has a hardened shoreline.

The performance criteria checked below are applied in the assessment of this subwatershed						
1. In-stream Artificial Barriers to Habitat				4. Water Quality		
1.1	Fish Passage	X		4.1	Water quality standards	X
	Data Gap			4.2	Sediment quality	
2. Sediment				4.3	Salmonid temperature requirement	
2.1	Embeddedness			4.4	Bull trout temperature requirement	
2.2	Fine sediment	X			Data gap	
2.3	Actively eroding banks			5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs			5.1	Shoreline buffer	
2.5	Sediment transport			5.2	Wetland, estuarine, and nearshore reserves	
	Data gap			5.3	Large woody debris	
3. Hydrology				5.4	Average stem diameter	
3.1	Total impervious area				Data gap	X
3.2	Annual hydrograph characteristics	X		6. Shoreline Condition and Floodplain Connectivity		
	Data gap			6.1	Shoreline hardening and overwater structures	X
					Data gap	

Tolt River – North Fork (headwaters – lower Tolt RM 8.4)
Snoqualmie River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Moderately Degraded
Access is naturally constrained for some salmonids in the lower mainstem of the North Fork. Steelhead occur upstream as far as the anadromous barrier, while resident rainbow, and possibly cutthroat and bull trout occur above the barrier (WDNR, 1993). Several blocking culverts exist on tributaries with potential habitat for steelhead and non-anadromous species (Washington Trout, 2001).

Habitat Condition 2. Sediment
Data Gap
The North Fork braided reaches, above Yellow Creek and below Titicaed Creek, have significant widening and mobilization of stored sediments. The reaches are braided with unstable, active channels and bars. The causes are summarized in WDNR Tolt Watershed Analysis Resource Assessment Reports (WDNR, 1993).

North Fork Canyon depositional area has dramatic pool filling. Large berms of gravel near the depositional zone are an indicator of a very mobile and large amount of bed material (WDNR, 1993).

Sediment sources have been major active slides and erosion areas near Titicaca Creek (RM 11.8) and along Road 6200 (RM 9.4 and 9.6) and Road 6244 (RM 13.9 and 14.1).[33] "Although it is unknown whether road construction in these areas initiated the slides and erosion, runoff from the road and road cuts is the cause of the continuing slide and erosion activity" (Morrison-Knudson Engineers, Inc., 1988). However, up to a 70% reduction in sediment supply is predicted over the next 50 years with scheduled road decommissioning and forest growth (Parametrix 2001).

Habitat Condition 3. Hydrology
Intact
Analysis of historic USGS gage data found no statistical evidence that forest harvesting has increased annual peak flows in the North Fork (WDNR, 1993).

Habitat Condition 4. Water Quality
Intact
Although prior studies discuss potential for elevated temperatures due to forest harvest and lack of shading, the data presented do not demonstrate this effect (WDNR, 1993). One data source shows temperatures in the lower mainstem North Fork to be well within target range (Morrison Knudsen, 1988). Otherwise, reaches downstream are within water quality parameters.

[33] Titicaed Creek and Titicaca Creek are different creeks.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
The majority of the riparian tree species within 70 feet of the channel are hardwoods, hardwoods mixed with young conifers, or solely young conifers. Average stem diameter is therefore less than 30cm dbh (WDNR, 1993).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Intact
As shoreline hardening is limited to isolated points for protection of forest roads, less than 10% of shorelines are affected.

The performance criteria checked below are applied in the assessment of this subwatershed

1. In-stream Artificial Barriers to Habitat		
1.1	Fish Passage	X
	Data Gap	
2. Sediment		
2.1	Embeddedness	
2.2	Fine sediment	
2.3	Actively eroding banks	
2.4	Feeder bluffs	
2.5	Sediment transport	
	Data gap	X
3. Hydrology		
3.1	Total impervious area	
3.2	Annual hydrograph characteristics	X
	Data gap	

4. Water Quality		
4.1	Water quality standards	X
4.2	Sediment quality	
4.3	Salmonid temperature requirement	X
4.4	Bull trout temperature requirement	
	Data gap	
5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
5.1	Shoreline buffer	
5.2	Wetland, estuarine, and nearshore reserves	
5.3	Large woody debris	
5.4	Average stem diameter	X
	Data gap	
6. Shoreline Condition and Floodplain Connectivity		
6.1	Shoreline hardening and overwater structures	X
	Data gap	

Tolt River – South Fork Above Dam (headwaters – S. Fork Below Dam RM 8.5)
Snoqualmie River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Intact
This subwatershed is above the South Fork Tolt Dam that is managed by Seattle Public Utilities to provide drinking water supply. The South Fork Tolt Dam is located upstream of a natural barrier waterfall. The dam itself does not block the upstream migration of anadromous salmonids. The dam may block the downstream migration of resident stocks located upstream of the dam (Binkley, June 2000). Within the Sorth Fork subwatershed, there are several culverts that block passage to non-anadromous species (Washington Trout, 2001).

Habitat Condition 2. Sediment
Degraded
The dam interrupts natural sediment transport.

The reservoir shows elevated turbidity due to past logging practices, failures of logging roads, and shoreline erosion from wave action. Logging practices and reservoir filling caused the active channel to more than double, with changes evident 5,000 feet upstream of the reservoir (WDNR, 1993). Past logging road failures in steep tributary drainages have contributed excess sediments, although some of these roads have been decommissioned (Glasgow, 2000).

Habitat Condition 3. Hydrology
Data Gap

Habitat Condition 4. Water Quality
Data Gap
The *Tolt River Watershed Analysis* presents conflicting information:
- "The high elevation of the South Fork basin suggests that water temperature is not likely to be a significant problem for streams draining to the reservoir."
- "Streams are generally devoid of shade and probably have elevated temperatures." (WDNR, 1993).

There are no 303(d) listed segments or sampling data.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
The majority of the riparian tree species within 70 feet of the channel are hardwoods, hardwoods mixed with young conifers, or solely young conifers. Average stem diameter is therefore less than 30cm dbh (WDNR, 1993).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Data Gap
The criterion does not address the condition of impounded waters.

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	X
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport	X	5.2	Wetland, estuarine, and nearshore reserves	
	Data gap		5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area			Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap	X	6.1	Shoreline hardening and overwater structures	
				Data gap	X

Tolt River – South Fork Below Dam (RM 8.5 – lower Tolt RM 8.4)
Snoqualmie River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Intact
One culvert blocks passage on a small tributary to Lynch Creek (Washington Trout, 2001).

Habitat Condition 2. Sediment
Degraded
The dam interrupts natural sediment transport.

Prior to the construction of the dam, a larger proportion of the substrate would have consisted of sand (Parametrix, Inc., 2002). The presence of the dam above this reach disrupts the routing of fines to the lower reach of the South Fork resulting in cleaner gravel. This data is supported by nine McNeil samples of 11% surface fines collected in 1993 (EBASCO Environmental, 1993) and an additional sample of seven percent collected in 2001 (Parametrix, Inc., 2002). In addition to the earlier gravel study (EBASCO Environmental, 1993), a study is underway to evaluate instream sources of gravel and current LWD function.

Habitat Condition 3. Hydrology
Degraded
The flow in this subwatershed is regulated by the South Fork Tolt water supply and hydroelectric projects. Water is withdrawn by the City of Seattle for municipal and industrial uses, under Superceding Reservoir Permit No. R-206 and Superseding Surface Water Permit No S1-10602. Instream flows are governed by a settlement agreement with resource agencies associated with the federal license for FERC Project 2959 (FERC, 1988).

USGS gage information before and after dam construction demonstrates altered peak flows, baseflows, and flow timing since dam construction (EBASCO Environmental, 1993).

"The necessity of recharging the South Fork reservoir following the summer high demand period results in a reduction of peak flows below the dam relative to inflow into the reservoir during the autumn months." "The timing and magnitude of peak discharges in the South Fork Tolt River has been altered by the operation of the Tolt Reservoir" (Stober et al., 1983).

Habitat Condition 4. Water Quality
Intact
There are no 303(d) listed segments.

The results of temperature monitoring upstream and downstream of the outfall of the South Fork hydroelectric project indicate that cooler temperatures exist downstream of the project, typically between the months of January and May. The temperature changes are well within the preferred temperature ranges of salmonids using the South Fork Tolt (Seattle City Light, 1998).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
The majority of the riparian tree species within 70 feet of the channel are hardwoods, hardwoods mixed with young conifers, or solely young conifers. Average stem diameter is therefore less than 30cm dbh (WDNR, 1993).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Intact
The subwatershed is virtually free of shoreline hardening.

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment	X		Data gap	
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport	X	5.2	Wetland, estuarine, and nearshore reserves	
	Data gap		5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area			Data gap	
3.2	Annual hydrograph characteristics	X	6. Shoreline Condition and Floodplain Connectivity		
	Data gap		6.1	Shoreline hardening and overwater structures	X
				Data gap	

Snohomish River Watershed Habitat Conditions

Cathcart Drainages

Snohomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
Elliot Creek is modified by five culverts and an abandoned diversion structure in the lower one-half mile. The diversion structure, a county culvert, and the Highway 522 culvert are all thought to be impassable to anadromous salmonids. Anderson Creek is blocked by impassable culverts. There is some diking of the mainstem in this reach (Highway 522 to lower end of Thomas' Eddy) that may restrict access to off-channel rearing areas (Carroll, 2001).

Habitat Condition 2. Sediment
Data Gap

Habitat Condition 3. Hydrology
Degraded
Total impervious area is estimated to be 14% (Purser and Simmonds, 2002). There is no contiguous canopy.

Habitat Condition 4. Water Quality
Degraded
Snohomish River tributaries are likely to have nonpoint sources of water pollution, but none are listed. In this reach, the Snohomish River has high stream temperatures, turbidity, bacteria, organics, and metals (Thornburgh and Williams, 2000).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Floodplain wetlands and riparian areas of Elliot, Evans, and Anderson creeks are all actively drained and farmed. Only 30% of the Snohomish River mainstem between the confluence of the Snoqualmie and Skykomish rivers and the head of Ebey Slough has riparian forest that is greater than or equal to one site potential tree height and that is not isolated by dikes or revetments (Haas and Collins, 2001). From pre-settlement conditions to the present, the riparian forest within the Snohomish River floodplain has shifted from a diverse, deciduous forest interspersed with large conifers to predominately monostands of cottonwood (Haas and Collins, 2001). Between 17,000 and 20,000 logs were removed from the Snohomish River by the U.S. Army Corps of Engineers between 1881 and 1968 (Haas and Collins, 2001).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Data Gap
Floodplain off-channel areas are drained, farmed, and roaded.

The performance criteria checked below are applied in the assessment of this subwatershed						
1. In-stream Artificial Barriers to Habitat				4. Water Quality		
1.1	Fish Passage	X		4.1	Water quality standards	X
	Data Gap			4.2	Sediment quality	
2. Sediment				4.3	Salmonid temperature requirement	X
2.1	Embeddedness			4.4	Bull trout temperature requirement	
2.2	Fine sediment				Data gap	
2.3	Actively eroding banks			5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs			5.1	Shoreline buffer	X
2.5	Sediment transport			5.2	Wetland, estuarine, and nearshore reserves	X
	Data gap	X		5.3	Large woody debris	
3. Hydrology				5.4	Average stem diameter	
3.1	Total impervious area	X			Data gap	
3.2	Annual hydrograph characteristics			6. Shoreline Condition and Floodplain Connectivity		
	Data gap			6.1	Shoreline hardening and overwater structures	
					Data gap	X

Dubuque Creek (headwaters – lower Pilchuck RM 8.5)
Snohomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Data Gap

Habitat Condition 2. Sediment
Data Gap

Habitat Condition 3. Hydrology
Moderately Degraded
Total impervious area is estimated to be 11% (Purser and Simmonds, 2002).

Habitat Condition 4. Water Quality
Degraded
There are no 303(d) listings. No temperature criteria exceedance is recorded for 1998. The 1999 stream temperature data show 11 of 18 days where stream temperature exceeds 18^{o} C (Snohomish County SWM, 1996).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Average stem diameter less than 30cm (Purser and Simmonds, 2002). Less than 70% of the shoreline has buffer width greater than one site potential tree height.

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Data Gap
There is lake shoreline hardening on Panther, Flowing, and Storm Lakes creeks, and overwater structures could be an issue.

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage		4.1	Water quality standards	X
	Data Gap	X	4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	X
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	X
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area	X		Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap		6.1	Shoreline hardening and overwater structures	
				Data gap	X

Everett Coastal Drainages

Snohomish River/Puget Sound

Nine small, second order streams discharge into Port Gardner (Possession Sound) along the western boundary of Everett (Golder, 2001). Limited aquatic information is available about them (Stober et al., 1981; Daley 1993; Mathias 1998 and 2000; and Golder, 2001). These streams have some potential to support chum and coho salmon, assuming adults and juveniles can negotiate migration impediments, and resident cutthroat trout (Golder, 2001). Self-sustained populations of chinook salmon are not likely to have occurred historically or currently due to the small size of the streams.[34]

Habitat Condition 1. Instream Artificial Barriers to Habitat
Data Gap (8) and Degraded (1)
The BNSF Railroad track right-of-way separates the streams and their riparian corridors from Port Gardner. Each stream flows through a culvert (typically three-foot diameter) passing under the railroad track. Fish access to the streams can only be negotiated at high tide because the culverts are often elevated above the sandy substrate or riprap along the nearshore marine environment. Elevations of these culverts would need to be determined in order to evaluate access for anadromous fishes. Even in a pristine state, access to the creeks by anadromous fishes would likely be limited to high tide because stream volume is low and the stream channels across the broad sand and mud intertidal area are ill-defined. The shallow, ill-defined channel crossing the mudflats would expose emigrating juvenile salmon smolts to avian predators during low tide (Golder, 2001). More information is needed on eight streams to be able to distinguish between natural or altered conditions, and Japanese Gulch has inhibited access (Daley, 1993).

Habitat Condition 2. Sediment
Data Gap (9)

Habitat Condition 3. Hydrology
Intact (1), Moderately Degraded (1), Degraded (7)
Total impervious area for Glenwood Creek is estimated to be below the threshold for "intact". One coastal drainage has an estimated total impervious area to be below the threshold for "moderately degraded". The estimated TIAs for seven of these drainages exceed 12%, the threshold for "degraded" (Purser and Simmonds, 2002).

Habitat Condition 4. Water Quality
Intact (4), Moderately Degraded (4), Data Gap (1)
There are no 303(d) listed segments in any of these drainages. Eight of the coastal drainages have been monitored for water quality since 1990. There are known water quality standards violations are for fecal coliform and lead in four drainages. With lead, there is an analytical problem with detection limits and differences between dissolved and total quantities, particularly during stormwater flows. The mean concentrations of fecal coliform exceed 100

[34] Chinook salmon typically inhabit at least third or fourth order streams (Bjornn and Reiser, 1991) that are larger than the small streams draining to Port Gardner.

colonies/100 ml in four streams. Over a 12-year period, mean temperatures for all monitored Everett coastal drainages are below 10º C. Thus, four tributaries with metal problems are “moderately degraded”.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Intact (1) and Degraded (8)
Data is not available on the percentage of intact historical wetlands or LWD. The buffer width for Narbeck Creek exceeds one site potential tree height for greater than 80% of its shoreline. Its condition is “intact”, while all others are below the 70% threshold.

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Intact (9)
The steep-walled ravines typical of these drainages have discouraged urbanization within the riparian zone. Therefore, shoreline hardening and overwater structures are uncommon within the stream shoreline areas (less than 10%).

The coastal drainages are non-alluvial channels. The steep walled, v-shaped valleys have been formed by downcutting through material deposited in the most recent glaciation. As floodplains were not a common feature of the Everett coastal drainages even before urbanization, floodplain connectivity is not used to assess the biological health of the streams.

Summary of Habitat Evaluations for Everett Coastal Drainages

Watershed	Area (ac)	Habitat Condition 1	Habitat Condition 2	Habitat Condition 3	Habitat Condition 4	Habitat Condition 5	Habitat Condition 6
Pigeon Creek 1	1,200	DG	DG	●	○	●	○
Pigeon Creek 2	910	DG	DG	◒	○	●	○
Glenwood Creek	380	DG	DG	○	◒	●	○
Phillips Creek	105	DG	DG	●	DG	●	○
Merrill-Ring Creek	800	DG	DG	●	◒	●	○
Narbeck Creek	450	DG	DG	●	◒	○	○
Powder Mill Gulch	1300	DG	DG	●	○	●	○
Edgewater Creek	220	DG	DG	●	◒	●	○
Japanese Gulch	935	●	DG	●	○	●	○

Legend: ○ — Intact ◒ — Moderately Degraded ● — Degraded DG — Data Gap

The performance criteria checked below are applied in the assessment of this subwatershed						
1. In-stream Artificial Barriers to Habitat				4. Water Quality		
1.1	Fish Passage	X		4.1	Water quality standards	X
	Data Gap	X		4.2	Sediment quality	
2. Sediment				4.3	Salmonid temperature requirement	X
2.1	Embeddedness			4.4	Bull trout temperature requirement	
2.2	Fine sediment				Data gap	
2.3	Actively eroding banks			5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs			5.1	Shoreline buffer	X
2.5	Sediment transport			5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X		5.3	Large woody debris	
3. Hydrology				5.4	Average stem diameter	
3.1	Total impervious area	X			Data gap	
3.2	Annual hydrograph characteristics			6. Shoreline Condition and Floodplain Connectivity		
	Data gap			6.1	Shoreline hardening and overwater structures	X
					Data gap	

Fobes Hill
Snohomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
Access is restricted by the Diking District 6 levee under most flow conditions (Snohomish County SWM, 1996; Woodward-Clyde Consultants, 1998).

Habitat Condition 2. Sediment
Degraded
Mosher Creek has 50% embeddedness in B and C Rosgen channel type reaches (Rosgen, 1996; Snohomish County PDS, 2001)

Habitat Condition 3. Hydrology
Degraded
Total impervious area is estimated to be 22%. (Purser and Simmonds, 2002). There is too much stormwater for the natural channel (Snohomish County SWM, 1996; Woodward-Clyde Consultants, 1998).

Habitat Condition 4. Water Quality
Data Gap
A Snohomish County reports indicates that low dissolved oxygen, high nutrient loading and high temperatures are suspected (Snohomish County SWM, 1996).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Less than 50% historic wetlands are present (Snohomish County SWM, 1996). There are less than 120 pieces of LWD/mile in channels that are less than 10m wide (Snohomish County PDS, 2001).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Degraded
Greater than 25% of the shoreline is hardened (Snohomish County SWM, 1996).

The performance criteria checked below are applied in the assessment of this subwatershed						
1. In-stream Artificial Barriers to Habitat				4. Water Quality		
1.1	Fish Passage	X		4.1	Water quality standards	
	Data Gap			4.2	Sediment quality	
2. Sediment				4.3	Salmonid temperature requirement	
2.1	Embeddedness	X		4.4	Bull trout temperature requirement	
2.2	Fine sediment				Data gap	X
2.3	Actively eroding banks			5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs			5.1	Shoreline buffer	
2.5	Sediment transport			5.2	Wetland, estuarine, and nearshore reserves	X
	Data gap			5.3	Large woody debris	X
3. Hydrology				5.4	Average stem diameter	
3.1	Total impervious area	X			Data gap	
3.2	Annual hydrograph characteristics			6. Shoreline Condition and Floodplain Connectivity		
	Data gap			6.1	Shoreline hardening and overwater structures	X
					Data gap	

French Creek (headwaters to Mainstem Snohomish RM 13.5)
Snohomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
The French Creek pump station located at the confluence with the Snohomish River acts as a complete barrier to chinook, chum, and pink salmon, and a partial barrier to coho, bull trout, steelhead and coastal cutthroat trout. In the upper subwatershed, several instream structures and culverts have been identified as full or partial barriers to upstream fish movement (Carroll, 1999).

Habitat Condition 2. Sediment
Degraded
Fine sediment (less than 6.3mm) in the French Creek subwatershed in Rosgen C channels (less than 2% gradient) average 37% (Snohomish County SWM, 2002). Fine sediment (less than 6.3mm) average 18% and 15% in A and B channels, respectively. It should be noted that Snohomish County fine sediment particle size threshold differs from the performance criteria. Mean bank instability by channel type is "intact" for Rosgen A (7.4%), B (3.1%) and C (3.6%) channels.

High sediment loads have been identified in Spada, Frylands, and upper Cripple creeks (Carroll, 1999).

Habitat Condition 3. Hydrology
Degraded
HSPF modeling for the subwatershed shows current baseflow problems in Cripple, Trench, Stables, and Alston creeks (Carroll, 1999). Total impervious surface is estimated to be 14% (Purser and Simmonds, 2002).

Habitat Condition 4. Water Quality
Degraded
Several segments are on the 303(d) list for fecal coliform and low dissolved oxygen (WDOE, 1997a). Snohomish County lists dissolved oxygen, bacteria, nutrients and temperature as problems for French Creek (Thornburgh, 1997; Thornburgh and Williams, 2000).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Historically there were over 3,950 acres (1,600 hectares) of wetland in the French Creek floodplain alone (Haas and Collins, 2001). Currently, wetland acreage is estimated at 1,800 acres (740 hectares) for the entire 17,900-acre (7,242 hectare) watershed (Meehan-Martin, 1998)—a loss of approximately 45%.

Riparian vegetation has experienced a similar reduction in quantity (Aldrich, 1999). The Snohomish River is diked along its extent through the French Creek drainage with little to no riparian corridor.

Streams (less than 10m bankfull width) in this subwatershed have a mean LWD (greater than 30cm diameter 7.5m from base) frequency of 0.04 pieces/bankfull width in Rosgen B and C channels and 0.05 pieces/bankfull width in A channels (Snohomish County Public Works SWM, 2002). Total wood debris including small woody debris (greater than 10cm diameter) averages between 0.42 and 0.45 in all channel types (Snohomish County Public Works SWM, 2002).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Degraded
One hundred percent of the Snohomish River streambank bordering the French Creek subwatershed is diked. Approximately 3,950 acres (1,600 hectares) of floodplain wetland have been lost to diking and draining (Haas and Collins, 2001). In French Creek and its tributaries upstream of the floodplain, between 3.6 and 7.4% of the channel shoreline is armored (Snohomish County Public Works SWM, 2002).

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			**4. Water Quality**		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	X
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment	X		Data gap	
2.3	Actively eroding banks		**5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD**		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	X
	Data gap		5.3	Large woody debris	X
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area	X		Data gap	
3.2	Annual hydrograph characteristics	X	**6. Shoreline Condition and Floodplain Connectivity**		
	Data gap		6.1	Shoreline hardening and overwater structures	X
				Data gap	

Lake Stevens Drainages
Snohomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Moderately Degraded
The weir at outlet of Lake Stevens prevents fish access during low flow periods. Culverts in upstream tributaries are known velocity barriers to access (Snohomish County PDS, 2001). The WDFW Fish Passage Culvert Database identifies 13 culverts as barriers (WDFW, 2002).

Habitat Condition 2. Sediment
Degraded
Fine sediment (less than 6.3mm) in streams of the Lake Stevens subwatershed average 59%, which is well above the threshold for the “degraded” classification (Snohomish County SWM, 2002). However, it should be noted that Snohomish County’s particle size threshold for fine sediment differs from the performance criteria. Mean bank instability is measured at 12% (“moderately degraded”) (Snohomish County Public Works SWM, 2002). Embeddedness levels in Fox and Centennial creeks exceed 30% (Snohomish County PDS, 2001).

Habitat Condition 3. Hydrology
Degraded
Total impervious area is estimated to be 22% (Purser and Simmonds, 2002). HSPF modeling of two-year and 100-year flows under forested and current conditions indicate a 400 - 500% increase in flows (50% increase in Catherine Creek) (R.W. Beck, 1997).

Habitat Condition 4. Water Quality
Moderately Degraded
Lake Stevens is listed on the WDOE 303(d) list for total phosphorus based on blue-green algae, tributary nutrient inputs, hypolimnetic anoxia, sediment phosphorus recycling, and stormwater (WDOE, 1997a).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Streams (less than 10m bankfull width) in the Lake Stevens subwatershed have a mean LWD (greater than 30cm diameter, 7.6m from base) frequency of 0.01 pieces/channel width. Including small woody debris (greater than 10cm diameter and one meter length), streams in the Lake Stevens subwatershed have a mean frequency of 0.17 pieces/channel width (Snohomish County SWM, 2002). Nearly the entire Lake Stevens shoreline is developed and less than 50% of historic wetlands are present (Snohomish County PDS, 2001).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Moderately Degraded
Greater than 25% of the Lake Stevens shoreline is hardened (Snohomish County PDS, 2001).

The performance criteria checked below are applied in the assessment of this subwatershed

1. In-stream Artificial Barriers to Habitat		
1.1	Fish Passage	X
	Data Gap	
2. Sediment		
2.1	Embeddedness	X
2.2	Fine sediment	X
2.3	Actively eroding banks	
2.4	Feeder bluffs	
2.5	Sediment transport	
	Data gap	
3. Hydrology		
3.1	Total impervious area	X
3.2	Annual hydrograph characteristics	X
	Data gap	

4. Water Quality		
4.1	Water quality standards	X
4.2	Sediment quality	
4.3	Salmonid temperature requirement	
4.4	Bull trout temperature requirement	
	Data gap	
5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
5.1	Shoreline buffer	
5.2	Wetland, estuarine, and nearshore reserves	X
5.3	Large woody debris	X
5.4	Average stem diameter	
	Data gap	
6. Shoreline Condition and Floodplain Connectivity		
6.1	Shoreline hardening and overwater structures	X
	Data gap	

Little Pilchuck Creek (headwaters – Lower Pilchuck RM 8.5)
Snohomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Data Gap

Habitat Condition 2. Sediment
Data Gap

Habitat Condition 3. Hydrology
Moderately Degraded
Total impervious area is estimated to be eight percent (Purser and Simmonds, 2002).

Habitat Condition 4. Water Quality
Data Gap
There are no 303(d) listings. 1998 data show that fecal bacteria levels exceed the criteria 33% of the time (Thornburgh and Williams, 2000).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Subwatershed wide, mature forests (average stem diameter assumed to be greater than 50cm) area coverage is at 0%, mixed forest (average stem diameter assumed to be 30 - 50cm) is 24%, and scrub/shrub (average stem diameter assumed to be less than 30cm) is 20% (Purser and Simmonds, 2002). Average stem diameter estimated to be less than 30cm.

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Data Gap

The performance criteria checked below are applied in the assessment of this subwatershed						
1. In-stream Artificial Barriers to Habitat				4. Water Quality		
1.1	Fish Passage			4.1	Water quality standards	
	Data Gap	X		4.2	Sediment quality	
2. Sediment				4.3	Salmonid temperature requirement	
2.1	Embeddedness			4.4	Bull trout temperature requirement	
2.2	Fine sediment				Data gap	X
2.3	Actively eroding banks			5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs			5.1	Shoreline buffer	
2.5	Sediment transport			5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X		5.3	Large woody debris	
3. Hydrology				5.4	Average stem diameter	X
3.1	Total impervious area	X			Data gap	
3.2	Annual hydrograph characteristics			6. Shoreline Condition and Floodplain Connectivity		
	Data gap			6.1	Shoreline hardening and overwater structures	
					Data gap	X

Marshland Drainages

Snohomish River

All creeks in this subwatershed (except Bigelow Creek) flow into the Marshland floodway, a broad ditched channel flowing northwest, and enter the Snohomish River through the Marshland pump station near Lowell.

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
The Marshland pump station blocks access for multiple salmonid species. On many of the tributaries, sediment settling ponds and perched culverts along the Lowell-Larimer Road also block fish access and migration. Tidegates block access into Batt's and Hanson sloughs.

A small number of sea-run cutthroat trout successfully enter the subwatershed through a tidegate upstream of the pump station (Tonnes, 2000). During floods (the Marshland dike is designed to overtop during a five-year event), it is highly probable that the Marshland drainages provides rearing and refuge habitat for juvenile salmonids.

Habitat Condition 2. Sediment
Degraded
Several of the creeks exhibited signs of high embeddedness and bank erosion (Toth and Houck, 2001). The sediment regime is altered by tributary channel confinement on alluvial fans and isolation of the Snohomish River from its floodplain. An altered sediment regime is further indicated by the need to remove sediment from settling ponds and to conduct periodic dredging and clearing of the Marshland floodway and associated ditches.

Habitat Condition 3. Hydrology
Degraded
Total impervious area for the subwatershed is estimated to be 19.5% (Purser and Simmonds, 2002), indicating a high probability of reduced baseflow. Reduced baseflows have not been documented through discharge measurements.

Habitat Condition 4. Water Quality
Degraded
There has been limited water quality monitoring of the Marshland tributaries and the Marshland floodway. Segment WA-07-1163 of Wood Creek is currently on the 303(d) list for dissolved oxygen levels (below 2.5 mg/L near the pump station). Monitoring by the Tulalip Tribes and Snohomish County throughout the subwatershed documents high fecal coliform and nutrient and turbidity levels (Thornburgh, 1996). Preliminary temperature data from the summer of 2000 indicate stream temperatures can exceed the criterion depending on location in the subwatershed (Toth and Houck, 2001).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Marshland was ditched and drained beginning in 1883 (IPC, 1906), resulting in a loss of approximately 1,950 hectares (4,875 acres) of wetland area (Haas and Collins, 2001). Marshland tributaries have functioning riparian forests upstream of Lowell-Larimer Road, but

76 km (47 miles) of ditched streams and ditches have no riparian forest cover (Haas and Collins, 2001). The Snohomish River has no riparian corridor in the Marshland drainage area, and there is no access to side channels.

LWD is absent in the floodplain tributaries and is highly variable upslope. For example, recent unpublished limiting factors analysis data indicates LWD ranges from zero in a reach of Wood Creek to almost one piece/meter in a Larimer Creek tributary (Toth and Houck, 2001).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Degraded
Historically, the Marshland floodplain provided hundreds of acres of off-channel rearing habitat. The entire Snohomish River shoreline along Marshland has been diked since the mid-twentieth century (Haas and Collins, 2001).

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	X
2.1	Embeddedness	X	4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	X
	Data gap		5.3	Large woody debris	X
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area	X		Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap		6.1	Shoreline hardening and overwater structures	X
				Data gap	

Pilchuck River – Lower (RM 8.5 – Snohomish RM 12.6)
Snohomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Moderately Degraded
No human-made barriers are present in the mainstem Pilchuck River or the portion of the channel network historically used by chinook salmon. However, culverts that block passage or create partial barriers have been found on the smaller tributaries that flow into the Pilchuck River (Loch and McHugh, 1998). Barriers on these small streams restrict use by coho salmon and cutthroat trout.

Habitat Condition 2. Sediment
Moderately Degraded
Most of the sediment in the Pilchuck River travels in suspension (Collins, 1991). The USGS determined a long-term average suspended sediment yield of 52,000 tons/year for the Pilchuck River (Collins, 1991). No significant sediment sources are found downstream of RM 7.5. Between RM 7 and RM 2, streambed degradation is likely to continue as a result of continued mining in excess of the natural bedload deposition rate of 500 - 2,500 cubic yards/year (Collins, 1991). Gersib et al., (1999) reports substantial increases in fine sediment production over historical levels in the lower Pilchuck River**.**

Habitat Condition 3. Hydrology
Moderately Degraded
Total impervious area is estimated to be 12% (Purser and Simmonds, 2002). A reduction in baseflows in the subwatershed has not been identified. Extensive floodplain alteration, diking, and the increases in development suggest that a reduction in baseflows should be occurring. Water withdrawals (by the City of Snohomish) that occur in the upper Pilchuck River subwatershed likely affect summer baseflows in this subwatershed. Gersib et al. (1999) suggested reduced baseflows occur or are likely to occur in the lower Pilchuck subwatershed.

At RM 1.9, the USGS has operated a gage since 1992. Gersib et al., (1999) suggests no altered flood flow characteristics occur in the lower Pilchuck subwatershed, although this conclusion is based on limited stream flow information.

Habitat Condition 4. Water Quality
Degraded
The Pilchuck River has been placed on the 303(d) list for excessive temperature and fecal coliform bacteria levels (WDOE, 1997a; also noted by Thornburgh and Williams, 2000). Gersib et al., (1999) suggested that metals (i.e., lead copper and zinc) are significantly higher than historical levels. The City of Snohomish discharges wastewater effluent into the Snohomish River.

The 1999 seven-day moving average temperature for spawning are “degraded” and for rearing are “moderately degraded” (Tulalip Tribes, unpublished data).

At RM 2.3, the biological indicator for benthic integrity (B-IBI) is 20. The lower Pilchuck River exhibits low richness of ephemeroptera, plecoptera and trichoptera (Tulalip Tribes, unpublished data). These species are indicators of water quality and habitat complexity for invertebrates and are considered to be intolerant of high temperatures and increased fine sediment loading.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Mature forests area coverage is at 0%, mixed forest at 26%, scrub/shrub at 22%, and crops/grass at 23% (Purser and Simmonds, 2002). Gersib et al. (1999) reports that 98% of stream miles in this subwatershed are either cleared or early seral stage. The Snohomish River is diked through its length in this area. There are no side channels and the riparian corridor is a single row of trees.

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Degraded
Diking, bank hardening, channel alteration, and riparian alteration have all reduced channel complexity in the lower Pilchuck River floodplain. Gersib et al., (1999) reports that 18% of the floodplain is disconnected from the channel network. A significant portion of the lower river has been diked and hardened (Collins, 1991). Based on the Collins report and work in progress (Tulalip Tribes, unpublished data), greater than 25% of the channel banks have been hardened.

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	X
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment	X		Data gap	
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	X
	Data gap		5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area	X		Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap		6.1	Shoreline hardening and overwater structures	X
				Data gap	

Pilchuck River – Middle (RM 28.5 – Lower Pilchuck RM 8.5)
Snohomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Moderately Degraded
No human-made barriers are present in the mainstem Pilchuck River or the portion of the channel network historically used by chinook salmon. Culverts block passage or create partial barriers for coho salmon and cutthroat trout on smaller tributaries of the Pilchuck River (Loch and McHugh, 1998)

Habitat Condition 2. Sediment
Data Gap
Most of the sediment in the Pilchuck River travels in suspension (Collins, 1991). The USGS determined a long-term average suspended sediment yield of 52,000 tons/year for the Pilchuck River (Collins, 1991). All significant sediment sources (from mass movement) are within the middle and upper subwatersheds (Collins, 1991). Several large mass wasting features are present along the Pilchuck River within this subwatershed. Surface and bank erosion are other important processes that provide a source of sediment to channels within this subwatershed.

Habitat Condition 3. Hydrology
Moderately Degraded
Total impervious area is estimated to be seven percent (Purser and Simmonds, 2002). Water withdrawals by the City of Snohomish in this subwatershed can take 10 - 20% of the summer low flow (Pentec and NW GIS, 1999). Gersib et al., (1999) suggests the presence of altered flood flow characteristics in the Middle Pilchuck River subwatershed.

Habitat Condition 4. Water Quality
Degraded
The Pilchuck River is on the 303(d) list for excessive temperature and fecal coliform bacteria levels (WDOE, 1997a). Exceedance of fecal coliform bacteria and temperature criteria has been reported by Snohomish County (Thornburgh and Williams, 2000). The 1999 temperature data for spawners are “intact” and were “moderately degraded” for rearing (Tulalip Tribes, unpublished data).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Mature forests area coverage is 1%, mixed forest is 42%, scrub/shrub is 32%, and crops/grass is 11% (Purser and Simmonds, 2002). Most riparian areas have buffer widths of less than one site potential tree height. Gersib et al., (1999) reported that 84% of stream miles in this subwatershed are either cleared or in an early seral stage.

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Moderately Degraded
Significant portions of the Pilchuck River shoreline in this subwatershed have been hardened (Collins, 1991). Approximately 15% of shorelines (5.32 river miles) are affected by road

encroachment (Savery, in prep.). Some bank hardening and riparian alteration has likely reduced channel complexity within the Middle Pilchuck River floodplain.

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	X
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	X
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X	5.3	Large woody debris	
3. Hydrology			5.4	Average stem diameter	X
3.1	Total impervious area	X		Data gap	
3.2	Annual hydrograph characteristics	X	6. Shoreline Condition and Floodplain Connectivity		
	Data gap		6.1	Shoreline hardening and overwater structures	X
				Data gap	

Pilchuck River – Upper (headwaters – Middle Pilchuck RM 28.5)
Snohomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
The City of Snohomish withdraws water from the Pilchuck at a diversion dam at RM 26.4. While the diversion dam has a fish ladder, it is still a barrier under varying flow conditions (Kraemer, 2001). Chinook salmon spawner surveys conducted in 1999 and 2000 did not locate spawners above the dam (Savery, 2001). Coho salmon, cutthroat trout, bull trout, and steelhead appear to access habitat above the dam. A comprehensive inventory of culverts in the Pilchuck watershed, in particular the upper Pilchuck, has not been conducted.

Habitat Condition 2. Sediment
Data Gap
All significant sediment sources are within the middle and upper subwatersheds (Collins, 1991). Mass wasting is the principal sediment generating process in this subwatershed. Many of the mass wasting and large bank erosion features appear to be principally composed of clay.

Habitat Condition 3. Hydrology
Data Gap

Habitat Condition 4. Water Quality
Intact
Water quality information for the upper Pilchuck River is very limited. Gersib et al., (1999) found no evidence of degraded water quality. There are no 303(d) listings for this subwatershed.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Moderately Degraded
Gersib et al., (1999) reports that 23% of stream miles in this subwatershed are cleared or in an early seral stage. This may equate to 70 - 80% of stream shoreline having a buffer of one site potential tree height or greater in width. Mature forests area coverage is 11%, mixed forest is 70%, scrub/shrub is 14%, and crops/grass is 2% (Purser and Simmonds, 2002). Average stem diameter is estimated to be 40cm.

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Moderately Degraded
A road runs along a large portion of the upper Pilchuck River. Its impacts have not been assessed. Approximately 17% of shoreline (2.8 river miles) is affected by road encroachment (Savery, in prep.).

The performance criteria checked below are applied in the assessment of this subwatershed						
1. In-stream Artificial Barriers to Habitat				4. Water Quality		
1.1	Fish Passage	X		4.1	Water quality standards	X
	Data Gap			4.2	Sediment quality	
2. Sediment				4.3	Salmonid temperature requirement	
2.1	Embeddedness			4.4	Bull trout temperature requirement	
2.2	Fine sediment				Data gap	
2.3	Actively eroding banks			5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs			5.1	Shoreline buffer	X
2.5	Sediment transport			5.2	Wetland, estuarine, and nearshore reserves	
	Data gap	X		5.3	Large woody debris	
3. Hydrology				5.4	Average stem diameter	X
3.1	Total impervious area				Data gap	
3.2	Annual hydrograph characteristics			6. Shoreline Condition and Floodplain Connectivity		
	Data gap	X		6.1	Shoreline hardening and overwater structures	X
					Data gap	

Quilceda/Allen Creek
Snohomish River/Puget Sound

Habitat Condition 1. Instream Artificial Barriers to Habitat
Moderately Degraded
The middle fork Quilceda Creek is obstructed above RM 3.8 (Nelson, 1995). Access by anadromous salmon may be restricted by tidal levels/tidegate in Allen Creek from Ebey Slough. The Fish Passage Culvert Inventory identifies five culverts: four in the Quilceda drainage (none identified as a barrier) and one barrier in the Allen Creek drainage (WDFW, 2002).

Habitat Condition 2. Sediment
Degraded
Gersib et al., (1999) reports substantial increases in fine sediment production over historical levels in both subwatersheds. Stream surveys conducted in 1993 (Nelson, 1995) and in 2000 (Snohomish County SWM, 2001) reports the dominant substrate composition to be sand and silt in most reaches surveyed (e.g., 89% or greater sediment of less than 6.3mm diameter for Rosgen C, E, and F channels in 2000).

Habitat Condition 3. Hydrology
Degraded
Total impervious area is estimated to be 27% for Quilceda Creek and 33% for Allen Creek ((Purser and Simmonds, 2002).

Habitat Condition 4. Water Quality
Degraded
Both Quilceda and Allen Creeks have been placed on the 303(d) list for dissolved oxygen and fecal coliform bacteria. An extensive water quality monitoring effort in both subwatersheds has shown these two parameters (thought to be from nonpoint sources) to be in violation of state water quality standards on a regular basis (Thornburgh and Williams, 2000; Snohomish County SWM, 1999; Paul and Nelson, 1996).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Based on the extent of the hydric soils in the two subwatersheds, only 15 - 25% of the historic wetland area remains (Snohomish County SWM, 1999). Many of the remaining wetlands have been substantially altered by development and agricultural activities (Snohomish County SWM, 1999). Approximately 20% of the reaches surveyed in 1993 had riparian buffer widths of more than 100 feet (Nelson, 1995). LWD frequency varies by channel type from a mean of 0.32 pieces/bankfull width in Rosgen E channels to a mean of 0.09 pieces/bankfull width in Rosgen C channels (Snohomish County SWM, 2001).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Degraded
Urban and agricultural land uses have led to loss of wetlands, riparian alteration, and reduced channel complexity over much of both systems (Snohomish County SWM, 1999). The ditching of channels and the loss of wetlands has reduced floodplain connectivity.

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness		4.4	Bull trout temperature requirement	
2.2	Fine sediment	X		Data gap	
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	X
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	X
	Data gap		5.3	Large woody debris	X
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area	X		Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap		6.1	Shoreline hardening and overwater structures	X
				Data gap	

Sunnyside Drainages
Snohomish River

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
Tidegates and dikes restrict access into the Sunnyside drainages. The Lake Stevens Master Drainage plan identifies several culverts that act as partial blockages to fish passage (Snohomish County PDS, 2001).

Habitat Condition 2. Sediment
Data Gap

Habitat Condition 3. Hydrology
Degraded
Total impervious area is estimated to be 16% (Purser and Simmonds, 2002).

Habitat Condition 4. Water Quality
Data Gap
High sediment loads are evident and the likely result of streambed and streambank degradation and lack of riparian corridors (Woodward-Clyde Consultants, 1998).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Less than 50% of historic wetlands are present (Woodward-Clyde Consultants, 1998) and extensive losses of estuarine tidal marsh have occurred (Haas and Collins, 2001).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Data Gap
The Sunnyside drainages are isolated from Ebey Slough by dikes and tidegates (categorized as “degraded” in Snohomish estuary subwatershed). Forty-eight percent of the total stream length in the Sunnyside subwatershed is within the floodplain. Nearly 100% of these streams have been ditched. The extent of bank armoring is unquantified, but significant (Snohomish County SWM, unpublished data).

The performance criteria checked below are applied in the assessment of this subwatershed						
1. In-stream Artificial Barriers to Habitat				4. Water Quality		
1.1	Fish Passage	X		4.1	Water quality standards	
	Data Gap			4.2	Sediment quality	
2. Sediment				4.3	Salmonid temperature requirement	
2.1	Embeddedness			4.4	Bull trout temperature requirement	
2.2	Fine sediment				Data gap	X
2.3	Actively eroding banks			5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs			5.1	Shoreline buffer	
2.5	Sediment transport			5.2	Wetland, estuarine, and nearshore reserves	X
	Data gap	X		5.3	Large woody debris	
3. Hydrology				5.4	Average stem diameter	
3.1	Total impervious area	X			Data gap	
3.2	Annual hydrograph characteristics			6. Shoreline Condition and Floodplain Connectivity		
	Data gap			6.1	Shoreline hardening and overwater structures	
					Data gap	X

Tulalip and Battle Creeks
Snohomish River/Puget Sound

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
Barriers at the mouths of both Tulalip and Battle creeks prevent access by anadromous species. Both streams are used to rear salmon for artificial production.

Habitat Condition 2. Sediment
Degraded
No sediment budgets have been developed for these subwatersheds. Mass wasting is not a dominant process. Stream surveys in 1997 report embeddedness levels ranging from 15% to 80%. Of the fifteen reaches surveyed in 1997, six of those reaches have some obvious signs of erosion (Haas et al., 1998). Both systems appear to have a high natural background level of fine sediment.

Habitat Condition 3. Hydrology
Intact
Total impervious area for Tulalip and Battle creeks are estimated to be 5% and 2.3%, respectively (Haas et al., 1998). Tulalip and Battle creeks were gaged in 1974-77 and are currently gaged as of September 2000. Wetland and lake surface area in Tulalip and Battle creeks account for 21.5% and 12.6% of the subwatersheds, respectively. (For Tulalip Creek, this figure is likely to be accurate for both historic and current conditions). These extensive wetland systems provide baseflow support (Haas et al., 1998). Neither subwatershed is located in the rain-on-snow zone.

Habitat Condition 4. Water Quality
Intact
No waterbody segments within these subwatersheds have been placed on the 303(d) list. In both subwatersheds, water quality monitoring results for parameters that are generally related to nonpoint sources of water pollution (e.g., fecal coliform bacteria and temperature) is consistent with state water quality standards. Mean dry season dissolved oxygen levels at six sites in Battle Creek ranged from 9.6 to 11.03 mg/L from 1991 to 1995. Minimum dissolved oxygen levels of 8.6 mg/L were recorded. Mean dry season temperature in Battle Creek ranged from 10.69º C to 12.76º C, from 1991 to 1995. Maximum recorded temperature was 16.3º C (Paul and Nelson, 1996).

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Most reaches have riparian buffer widths of greater than 30m (Haas et al., 1998) but less than one site potential tree height. Past logging has reduced LWD recruitment in the near term. LWD in Tulalip and Battle Creek ranges between 132 pieces/km to 362 pieces/km (1.3 to 3.2 pieces/stream width). Width-to-depth ratios range from 2 to 35.2 (Haas et al., 1998).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Data Gap

The performance criteria checked below are applied in the assessment of this subwatershed					
1. In-stream Artificial Barriers to Habitat			4. Water Quality		
1.1	Fish Passage	X	4.1	Water quality standards	X
	Data Gap		4.2	Sediment quality	
2. Sediment			4.3	Salmonid temperature requirement	
2.1	Embeddedness	X	4.4	Bull trout temperature requirement	
2.2	Fine sediment			Data gap	
2.3	Actively eroding banks		5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs		5.1	Shoreline buffer	X
2.5	Sediment transport		5.2	Wetland, estuarine, and nearshore reserves	
	Data gap		5.3	Large woody debris	X
3. Hydrology			5.4	Average stem diameter	
3.1	Total impervious area	X		Data gap	
3.2	Annual hydrograph characteristics		6. Shoreline Condition and Floodplain Connectivity		
	Data gap		6.1	Shoreline hardening and overwater structures	
				Data gap	X

Nearshore Area and Snohomish River Estuary Habitat Conditions

Nearshore Area

Snohomish River

The nearshore area includes the marine areas of Port Gardner, eastern Possession Sound, and southern Port Susan from Mukilteo (Elliott Point) to McKees Beach (just south of Kayak Point). Upstream boundaries of the nearshore area are defined as Priest Point on the northeast and the mouth of the lower Snohomish River channel on the south. The nearshore area also includes the Snohomish River delta, the west shore of Jetty Island and Hat (Gedney) Island. The nearshore area has been defined to extend to depths of 30m—the approximate limit of the photic zone in central Puget Sound (Battelle et al., 2001).

Habitat Condition 1. Instream Artificial Barriers to Habitat
Intact
There are no barriers to upstream, downstream, or long-shore migration in the nearshore. Overwater structures in the east waterway may delay longshore movements of juvenile salmonids, although studies designed to explore this issue have not identified significant consequences to salmonid health or survival (e.g., Pentec, 1997; Simenstad and Nightingale, in prep.).

Habitat Condition 2. Sediment
Degraded
Between 50 and 75% of the historic feeder bluffs have been isolated from the beach; these are largely along the east waterway to Mukilteo shoreline and again in areas between Priest Point and Mission Beach. Scattered additional limitations on feeder bluff function occur along the Port Susan and Hat Island shorelines. Isolation of feeder bluffs from the adjacent beaches reduces sources of sediment that are essential to maintenance of beach substrata and morphology. For example, loss of sediments from feeder bluffs can result in beaches becoming dominated by coarser materials and lower elevations, as has occurred along significant reaches of the shoreline between Everett and Mukilteo.

Human-made structures such as bulkheads and riprap also interfere with natural longshore sediment transport in these same areas. In addition, dredged channels and piers like those in the East Waterway, the Hat Island boat access, and the old Navy fuel dock also interfere with longshore transport.

Habitat Condition 3. Hydrology
Data Gap
Hydrology in this subwatershed is driven by tidal circulation. Human-made structures such as bulkheads, riprap, dock and piers, and human activities such as dredging have altered the hydrology in proximity to these features.

Habitat Condition 4. Water Quality
Degraded
The nearshore has numerous 303(d) listings (WDOE, 1998).[35] Deepwater areas (generally deeper than -30 ft MLLW) in Port Gardner and inner Everett Harbor are listed for phenol, total PCBs, zinc, benzo(a)pyrene, benzo(b,k) fluoranthenes, benzo(ghi)perylene, benzyl alcohol, bis(2-ethylhexyl)phthalate, chrysene, di-n-octyl phthalate, fluoroanthene, fluorene, mercury, naphthalene, pentachlorophenol, phenanthrene, phenol, 2, 4-dimethylphenol, 2-methylnaphthalene, 2-methylpenol, 4-methylpenol, and acenaphthene. The net effect of contaminants on fish species depends upon their use of the nearshore habitat in general and of the particular areas of contamination.

Temperatures in certain marshes and on the broad flats west of Jetty Island are known to reach levels in excess of 20° C (Pentec, 1992). Detailed water temperature information is lacking in the subwatershed.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
The majority of the nearshore zone is relatively intact. Losses of associated habitat adjacent to the East Waterway and along the shoreline to Mukilteo have been less than 20% of those historically present. However, logging and shoreline modifications have greatly reduced the quality of the riparian vegetation adjacent to the marine shorelines in the subwatershed leading to an assessment of “degraded” for this habitat condition. While riparian function in nearshore areas is not well studied, it is clear that shading by riparian vegetation does improve upper beach conditions for benthos and for spawning by forage fish (Battelle et al., 2001). While LWD in the nearshore lacks many of its critical functions in the upper watershed, it does serve to moderate sediment transport and may help stabilize the backshore. However, the amount of LWD necessary to provide these functions is not known and no assessment is made based on this criterion.

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Degraded
Shoreline hardening is estimated to affect about 40% of the nearshore area (City of Everett and Pentec, unpublished data; Houghton, May 2000). This hardening and associated fills have resulted in losses estimated at less than 20% of the historic mudflats in the nearshore (from OHW to -30m MLLW).

[35] Most of the parameters on the candidate list are for sediment quality.

The performance criteria checked below are applied in the assessment of this subwatershed		
1. In-stream Artificial Barriers to Habitat		
1.1	Fish Passage	X
	Data Gap	
2. Sediment		
2.1	Embeddedness	
2.2	Fine sediment	
2.3	Actively eroding banks	
2.4	Feeder bluffs	X
2.5	Sediment transport	X
	Data gap	
3. Hydrology		
3.1	Total impervious area	
3.2	Annual hydrograph characteristics	
	Data gap	X
4. Water Quality		
4.1	Water quality standards	X
4.2	Sediment quality	X
4.3	Salmonid temperature requirement	X
4.4	Bull trout temperature requirement	
	Data gap	
5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
5.1	Shoreline buffer	X
5.2	Wetland, estuarine, and nearshore reserves	X
5.3	Large woody debris	
5.4	Average stem diameter	
	Data gap	
6. Shoreline Condition and Floodplain Connectivity		
6.1	Shoreline hardening and overwater structures	X
	Data gap	

Snohomish River – Estuary
Snohomish River/Puget Sound

Habitat Condition 1. Instream Artificial Barriers to Habitat
Degraded
No barriers exist to upstream or downstream migration in the largest migratory passages: the Snohomish River, Ebey Slough, Steamboat Slough, and Union Slough. Former barriers to migration in these distributary channels that resulted from industrial and municipal wastewater discharges have been eliminated by collection and treatment programs. An unnamed distributary slough of nearly one mile in length (connecting between the mainstem and Steamboat Slough on Smith Island downstream of I-5) has been isolated at both ends by a tidegate and fill. This restricts salmonid movement among distributary sloughs, but it does not prevent upstream or downstream migration of salmon. Tidegates, pump stations, and dikes also partially restrict access into numerous small tributaries that flow into the estuary. Potential adult and juvenile usage of several tributary creeks (e.g., Woods, Bigelow, Allen, and the Sunnyside drainages) is blocked by dikes, tidegates, or pump stations.

Habitat Condition 2. Sediment
Degraded
The sediment regime in the estuary is affected by upstream basin-wide land use changes, restriction of downstream flow and tidal circulation in the estuary, and local drainage. The diking system forces sediment deposition to occur in the channel mouths rather than into the adjacent tidelands. The Army Corps of Engineers has constructed and maintained a navigation channel and flow training structures (e.g., Jetty Island) that have altered the mode of delivery of sediments to the delta. The effects of this modification are evident primarily in the Nearshore subwatershed where delta formation is interrupted along the southern portion of the delta.

Habitat Condition 3. Hydrology
Degraded
The hydrology of the estuary has been dramatically altered by construction of levees that have disconnected the river from the tidelands and marshes where it once had frequent interactions. As a result, water is routed down the stabilized channels of the estuary. Altered hydrologic regimes in upstream subwatersheds may alter peak flows and baseflow into the estuary. However, because of tidal estuarine circulation, changes in delivery rates of water to the estuary do not carry the concomitant effects on salmonid habitat function found in non-tidal subwatersheds. Similarly, while a high percentage of total impervious area in small tributaries does indeed degrade their condition (e.g., increased peak flows, decreased low flows), these changes do not significantly alter the hydrology of the estuary.

Habitat Condition 4. Water Quality
Degraded
The estuary has numerous 303(d) listings (WDOE, 1998). Ebey Slough is listed for pH, fecal coliform, and water column bioassay and the mainstem Snohomish River is listed for dissolved oxygen and fecal coliform. The cities of Everett, Marysville, and Lake Stevens discharge wastewater effluent into the estuary.

Low levels of dissolved oxygen may in part reflect natural conditions. WDOE noted that low dissolved oxygen in the estuary is correlated with intrusion of low dissolved oxygen marine water (WDOE, 1997b). Also, the basis for some listings such as water temperature and dissolved oxygen are either no longer valid or are questionable (unverified sampling) (WDOE, 1998). Temperatures in certain marshes and on the broad flats west of Jetty Island are known to reach levels in excess of 20° C (Pentec, 1992). Detailed water temperature information is lacking in the subwatershed.

Sediment in the mainstem is listed for fluorene, naphthalene, phenanthrene, acenaphthene, arsenic, and dibenzofuran. The net effect of contaminated sediment on fish species depends upon their use of estuarine habitat in general and of the particular areas of contamination.

Habitat Condition 5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD
Degraded
Prior to settlement by non-native people in the mid-19th century, approximately two-thirds of the estuary was composed of forested wetland (Haas and Collins, 2001). In the transitional zone between the forested wetland and emergent marsh, significant tree cover was also present on natural levees along the mainstem and distributary sloughs (Haas and Collins, 2001).

Streamside buffers are less than one site potential tree height over a large percentage of the estuary; less than half the assessment units (AU) in the estuary have riparian vegetation even 25 feet wide over 50% of the AU shoreline (City of Everett and Pentec, 2001). There were approximately seven square miles of forested wetland and 11 square miles of emergent wetland in the Snohomish River delta in about 1855. Greater than 80% of the riparian zone in the Snohomish estuary is cleared or early seral. Eighty-five percent of historic tidal marsh is not intact (Haas and Collins, 2001). Large woody debris is sparse—only about 20% of AU had one piece of LWD/channel width (City of Everett and Pentec, 2001). Lack of large logjams in the estuary may reduce the frequency of new channel formation (Haas and Collins, 2001).

Habitat Condition 6. Shoreline Condition and Floodplain Connectivity
Degraded
Forty-four miles of dikes isolate the river from the riparian environment (Pentec and NW GIS, 1999).

The performance criteria checked below are applied in the assessment of this subwatershed						
1. In-stream Artificial Barriers to Habitat				4. Water Quality		
1.1	Fish Passage	X		4.1	Water quality standards	X
	Data Gap			4.2	Sediment quality	X
2. Sediment				4.3	Salmonid temperature requirement	
2.1	Embeddedness			4.4	Bull trout temperature requirement	
2.2	Fine sediment				Data gap	
2.3	Actively eroding banks			5. Wetlands/Riparian Zone and Shoreline Vegetation/LWD		
2.4	Feeder bluffs			5.1	Shoreline buffer	X
2.5	Sediment transport	X		5.2	Wetland, estuarine, and nearshore reserves	X
	Data gap			5.3	Large woody debris	X
3. Hydrology				5.4	Average stem diameter	
3.1	Total impervious area				Data gap	
3.2	Annual hydrograph characteristics	X		6. Shoreline Condition and Floodplain Connectivity		
	Data gap			6.1	Shoreline hardening and overwater structures	X
					Data gap	

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